missiles and rockets

THE MISSILE/SPACE WEEKLY

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Successful First Launch of Minuteman

Fifth Annual

World Missile/Space Encyclopedia

This issue, $1.00

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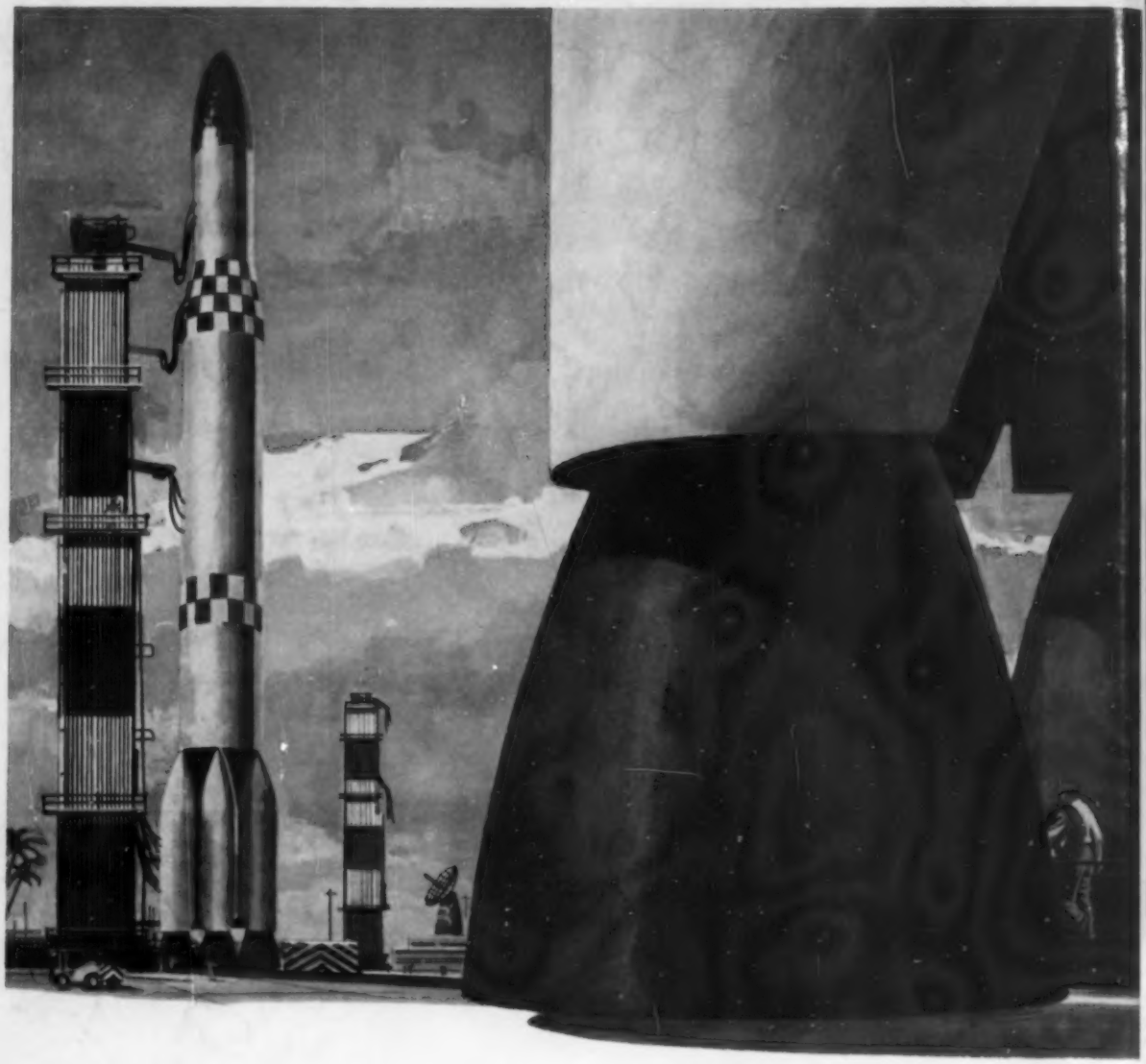

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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 9, Number 3 July 17, 1961

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THE COVER

A milestone in U.S. missilery was successful first launch Feb. 1 of Air Force's Boeing Minuteman ICBM. M/R's Fifth Annual Missile/Space Encyclopedia starts on p. 16.

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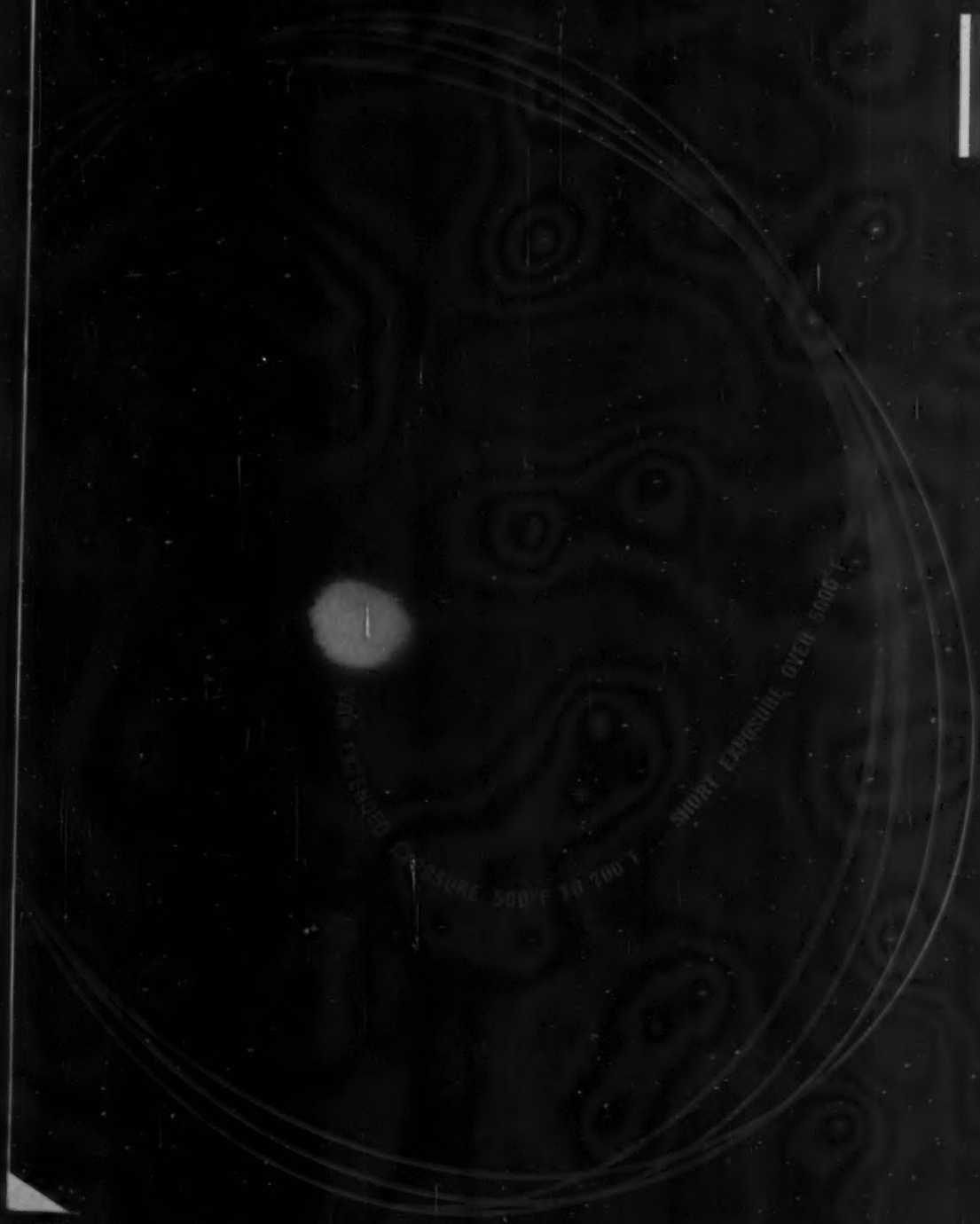

NEW M/R EDITORS, Hal Taylor (left) and Tim Trainor, hold forth at staff meeting.

memo from the publisher

IT IS ALWAYS a pleasure to receive a letter from a missile/space firm complimenting us on the competence and technical knowledge of a MISSILE AND ROCKETS editor who has visited the plant. We often are asked where we find these editors and what their background is. By telling you about the two gentlemen pictured above, both of whom have joined the M/R editorial staff in the past month, we may be able to answer those questions.

Hal Taylor, left, joins us from the Washington bureau of the Journal of Commerce, where he covered foreign trade and investment, international finance, and a number of government departments, including State and Interior. For a year, he was the Journal's Supreme Court correspondent. Hal is that most valuable of men—a good reporter.

He combines it with a knowledge of the industry. During two years in the Army, his principal assignment was in supply work for *Nike* sites in the Washington, D.C., and Maryland areas.

Before his Army stint, Hal briefly attended Johns Hopkins University. He obtained his bachelor of science degree from the University of Maryland in 1959. His hometown is Blakely, Pa. Hal's knowledge of government agencies is being put to good use. We've assigned him to NASA, replacing Jay Holmes, who has resigned.

Jim Trainor, right, comes to us after more than three years on U.S. Army missile programs. After graduation from West Point, he spent two years with the 209th Artillery Group *(Redstone)* at Ft. Sill, Okla. There, he participated in the planning, testing and launch operations of seven *Redstone* firings, including both Engineer-User tests and Annual Service Practice Firings.

Trainor was transferred in 1960 to Redstone Arsenal, where he worked in the program coordination office for the *Pershing* missile system. He later served as chief of the Combat Requirements Branch in the Advanced Plans Division of ABMA, translating the Army's future missile requirements into specific weapon system plans.

Like Taylor, Trainer also has a good background in journalism. Before his appointment to West Point, he put in five years on the Detroit Free Press, first as a copyboy and later as a rewrite man. While at Redstone Arsenal, he worked part-time on the Huntsville, Ala., Times. Jim replaces Hal Gettings, who has left us to join Dynatronics, Inc., as advertising and public relations manager in Orlando, Fla.

•

WHILE WE ARE on the subject of staff members, we know her friends will be pleased to hear that our very capable Space Medicine Editor, Heather David, has just produced a Little David satellite, female-type, orbital weight seven pounds, 13 ounces, launch site: Sibley Memorial Hospital, Washington, D.C. To add to her husband's nervousness, Heather insisted on working right up to the start of countdown and actually had a hand in the preparation of this week's issue.

•

IT IS to hard-working people such as these that we are indebted for the coverage which has pushed MISSILES AND ROCKETS paid circulation above the 33,000 mark for the first time, effective with this issue. That's a gain of almost 3000 in the past six months.

In addition to those 33,000 subscribers, this annual special issue of M/R will go by request to another 7500 members of the military establishment and the National Aeronautics and Space Administration. ⠿

Edward Muhlfeld

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letters

Thanks Are Ours

To the Editor:

Thank you for reprinting my memorandum on Columbus ("New Route to Cathay—Step by Step," M/R, May 29, p. 37), which several people felt was fitting of wider distribution than internal laboratory.

There was one misprint (my fault) in the original which may arouse historians or Englishmen among the readers; that is, Henry III should read Henry VII. Our statement would be equivalent to crediting McKinley with the Louisiana Purchase.

Ralph S. Cooper
Los Alamos Scientific Laboratory
University of California
Los Alamos, N.M.

French Propellant

To the Editor:

Your issue of June 5 includes an article on French and British progress in the field of rockets. In this article, under the subtitle "French potpourri" you reported that certain firms associated in the SEREB program complained that their own progress was impeded by the Service Industriel des Poudres (Industrial Propellant Division), which is responsible for furnishing solid propellant grain.

We are astonished that a magazine with the prestige of your publication would publish without verification any information which might tarnish the name of the highly reputable Service Français des Poudres (French Propellant Agency). We believe that the writer of this article was taken advantage of by an irresponsible news source whose particularly flighty opinion was manifestly unsupported by any facts.

As a rule we do not comment on passing press reports, but because we are a MISSILES AND ROCKETS subscriber we feel obliged to point out the surreptitious character of this information, especially incompatible with the spirit of your magazine, usually so painstakingly accurate.

L'Ingénieur Général Militaire
Tavernier
Directeur des Poudres
Paris

The report published in M/R came from several highly placed sources in French industry.—Ed.

Tough Skating

To the Editor:

Mr. Rabinow's report in M/R, June 12, attempts to discredit Mr. (Norman) Dean's complicated demonstration of rotary-to-linear thrust without counter-thrust.

However, in the very last paragraph (on p. 42) doesn't Rabinow incorrectly say, in effect, that you can't move on roller skates by "body English"? You don't absolutely need friction between yourself and the floor to get some forward motion, although friction helps of course in many "leap-frogging" actions. Further, wouldn't the cited load be moved the stated distance from the Dean model's plumb line, if attached to the suspended platform (i.e., "fixed frame")?

Will you or Mr. Rabinow comment on the above error in the subject analysis?

H. Dudley Kellogg
(Member Franklin Institute)
Narberth, Pa.

A risky but instructive experiment would be to try using body English as a propelling force while standing on roller skates on ice.

Yes, the load does move—which is the basis of the Dean patent—but not without reaction exterior to the system.—Ed.

Saturn by Blimp?

To the Editor:

I am writing about the letter, "Saturn by Dirigible," from C. W. Farrar (M/R, July 10, p. 7). Mr. Ferrar proposes to move the *Saturn* booster to Cape Canaveral by an all-metal airship, but Maj. Gen. Don R. Ostrander (NASA Director, Launch Vehicle Programs) claims that total costs, both developmental and operational, would be too high.

Time magazine of July 7 states that the U.S. Navy blimp program is to be suspended, and that by next December all but two of the blimps will be stored.

Could not these blimps be used for the transportation of the *Saturn* booster? This would eliminate the development cost of the all-metal airship.

David W. Johnston
Washington, D.C.

A larger dirigible would be required to lift the relatively large Saturn stages.—Ed.

Mud for Moon Shelters

To the Editor:

Present space travel concepts are based upon the idea of taking all the material needed on a moon trip and returning to the earth. But, in view of the enormous cost of the Kennedy moon program, such concepts are in need of reappraisal.

A saving of one pound at the lunar end of the flight will mean a saving of at least 10,000 lbs. at the earth end, even with improved rocket performances, while elimination of the return trip will raise this to at least 30,000 lbs.

If half the other operations in the Kennedy program are reduced in the same proportion as the actual moon voyage, elimination of the return trip alone will

One of the many promising studies now being conducted by Lockheed/Georgia scientists involves injecting a hypergolic agent into a fuel tank—and using the gas resulting from the combustion to pressurize storable propellants. This program, under U. S. Air Force contract, is typical of the many advanced aerospace research activities currently in progress at the Georgia Division.

LOCKHEED/GEORGIA
Marietta, Georgia

reduce a $40,000,000,000 project to $13,377,000,000 plus.

This fact underlies the importance of primitive survival techniques to enable one to live on the moon with a minimum of equipment from the earth.

Shelter, by far the heaviest item, merits special discussion. Excavation machinery will be out of the question for one wanting a really "go light." Natural caves cannot be depended upon, and will still have to be rendered air-tight. Above-ground shelters will therefore be a "must."

Transporting the shelter from the earth might involve as large a weight penalty as a return trip; bringing up commercial cements to bond lunar material together would again involve costly weight penalties.

Zwicky's proposal for welding rocks together would require costly equipment for producing high temperatures in quantity, as well as a serious cracking problem. But cementing with frozen mud would appear perfectly practicable under lunar shade conditions, for which the polar regions will be especially favorable.

Drying should be superficial at temperatures where the free path of the water-vapor molecules will be larger than the pore space. The mud can be sprayed from a gun, like stucco, and will freeze almost instantly at such temperatures.

Meteor and radiation protection will be provided automatically. And fossil ice or absorbed gases for water and oxygen production should be especially abundant at the lunar poles.

Theodore B. Dufur
Los Angeles

UFO's Will Rise Again

To the Editor:

I somehow missed until recently your scintillating reply to my questions on the USAF saucer snow job. Might I ask if you are *really* interested in curtailing data suppression and falsification of information or are you just pretending when you editorialize about the evils of censorship and governmental deceit? . . .

George W. Earley
Bloomfield, Conn.

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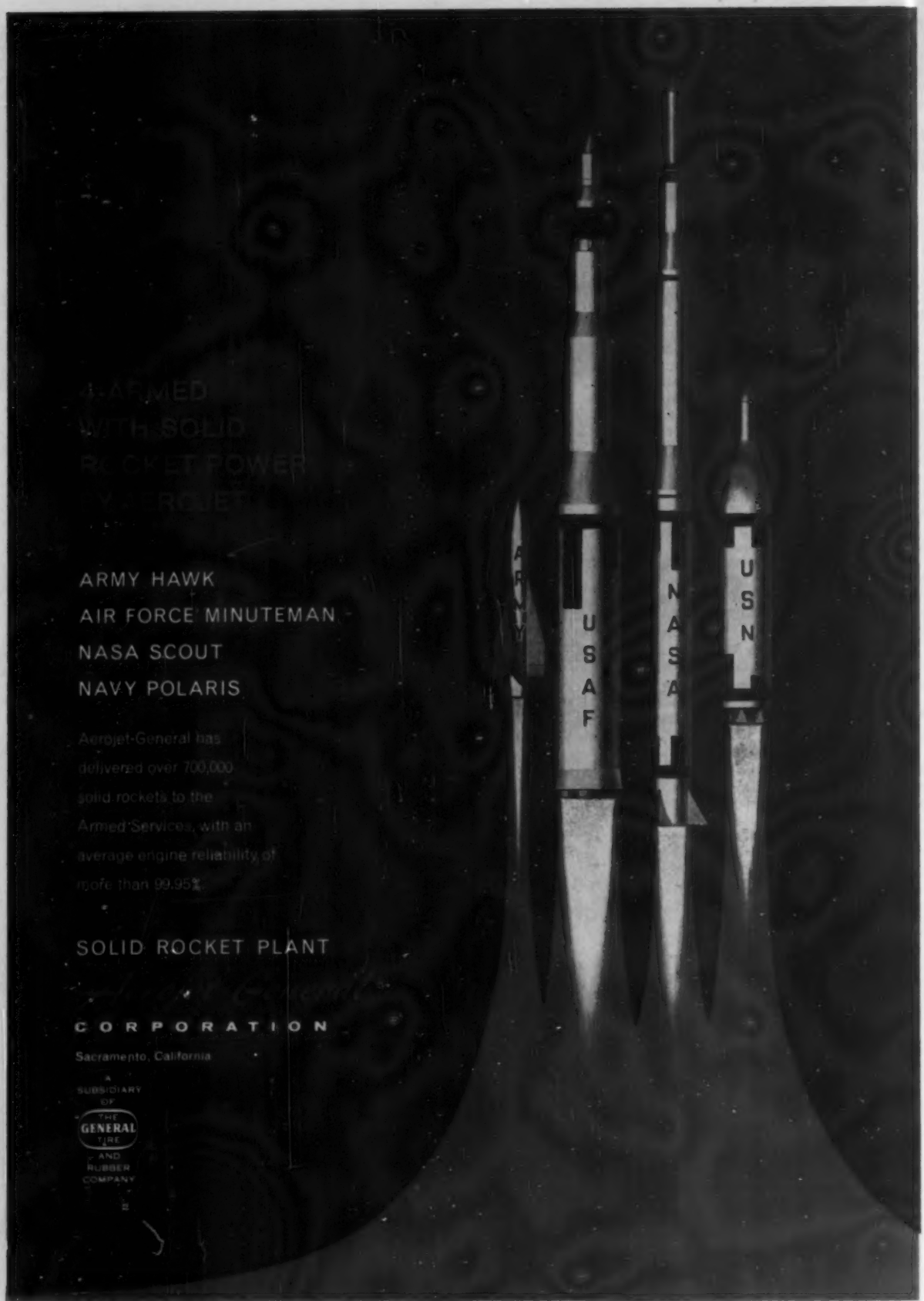


Engineers, scientists — investigate outstanding opportunities at Aerojet

The Countdown

WASHINGTON

Missiles and Berlin

Military experts say the Administration is much too late in trying to strengthen conventional forces to cope with a Russian move on Berlin. They say only nuclear bombs and missiles will deter the huge Red Army and that faster deployment of such weapons as *Davy Crockett* would do far more to maintain the peace than a couple of reserve divisions.

Looking for T-3's

Administration officials continue to leak the comforting report that the Missile Gap is growing narrower and narrower. The interesting proof: U-2-less intelligence has not been able to locate positively any large number of sites. Ergo, if you can't find the enemy, he must have gone away.

SS-11 Wins Army Airborne Role

The Army has firmly decided to deploy the Nord *SS-11* as an airborne and vehicle-carried antitank missile. An agreement has been signed with Nord to manufacture *SS-11's* in the United States. The Army previously designated Nord's *Entac* its hand-carried antitank missile.

Operational Titan Slips

The first operational *Titan I's* at Lowry AFB are now expected to be ready for emergency use if necessary later this year, but the base is not expected to be declared operational until early 1962. Originally, the first squadron at Lowry—first in the *Titan* ICBM force—was scheduled to be operational this summer.

Space Bill Agreement Seen

Members of the Senate and House Space Committees are expected to reach agreement within the next week on the revised $1.7-billion NASA authorization bill. The House already has passed the earlier $1.3-billion version but is expected to go along with the Administration-sought Senate bill. Floor action is expected to follow quickly after the conference committee meets.

Moscow Said "Thanks"

Friendly scientists at NASA sent the Russians some space-snapped pictures of cloud cover over the Soviet Union. NASA also asked the Russians to supply information about weather conditions in the Soviet Union, as observed from the ground, to compare notes. The Russians replied they don't want to play that game. But they said thanks for the pictures, anyway.

INDUSTRY

F-1 Firings Begin

First static firings of the Rocketdyne F-1 engine, now under way, will gradually build up to the rated top thrust of 1.5 million lbs. Tests should shed some light on problems of propellant feed systems for liquid boosters of over 20 million lbs. total thrust. Engineers feel pump-fed and pressure-fed techniques have major disadvantages and they may have to shift to a delta-P or gravity-head system.

R&D Intelligence

NASA feels low wattage yield of nuclear power sources makes them unsuitable for both *Tiros* and follow-on *Nimbus* weather satellites . . . AMC has put out a request-for-proposal to fabricate an electro-formed part which will withstand 3500°F for at least 100 hours. Component reportedly is for leading edge of a wing . . . Nine different methods of thrust vector control are under study by Aerojet-General for large solid-rocket boosters. Most promising: liquid injection to create a shock wave which will divert exhaust stream.

Air-snatch for Drones

Air Force is considering air-snatch recovery of target drones based on the *Discoverer* system. One system is being tried out on a Kaman helicopter at Holloman AFB. Potential savings in preventing saltwater landings: $5 million in reduced maintenance.

Minuteman Dividend

The Air Force says experience gained in *Minuteman* has saved about 20% in the estimated development cost of the Douglas *Skybolt* propellant, a polyurethane with aluminum additive. The two-stage ALBM has an optional coast phase which can be utilized between stages for range adjustments and a gimballed second-stage nozzle for precise thrust vector control.

Fast Switch

Crew of four Dynatronics engineers cut a gear box out of an antenna at Eglin AFB and flew it to San Nicolas Island off Point Mugu, Calif., to fix a *Tiros* antenna that went out July 4. The fast switch—under difficult field conditions—enabled NASA's *Tiros* shot to go July 12 with only one day's delay.

INTERNATIONAL

Sweden Buys Bloodhounds

The Royal Swedish Air Force has awarded a multi-million-pound order to British Aircraft Corp. for *Bloodhound Mark II* surface-to-air missiles. The order is said to be the largest ever placed by a foreign government for British missiles. No specific amount has been disclosed. Meantime, British Aircraft is reported to be preparing to announce another large order within the month.

Aussies Developing ASW Missile

The Australian Department of Supply has under development an ASW booster for the Mark 44 torpedo. The missile is said to have twice the range of *Asroc*, which also carries the Mark 44. The U.S. has contributed $4 million to the program.

Vigilant Struts Its Stuff

High-ranking officers from France, Britain, the United States and Yugoslavia watched the first demonstration of the Vickers *Vigilant* antitank missile in England earlier this month. Score against four moving Centurion tanks: 12 hits, one miss.

The Missile/Space Week

First Midas Scans USSR

The Air Force launched a 3500-lb. *Midas* IR early warning satellite into a circular 1850-mi.-high orbit July 12 with an *Atlas-Agena B* from Point Arguello, Calif.

Midas III's 160-min. orbit is taking it over Russia as well as every other point on earth in a test of its detection payload. Presumably it will be tested against U.S. missiles launched at the Cape and Vandenberg AFB. Tracking and readout stations are at Vandenberg, Kaena Point, Hawaii, and New Boston, N.H., with systems control at Sunnyvale, Calif.

In two previous shots from the Cape last year, the first failed to orbit and the radio transmitter of the second failed shortly after it went into orbit.

Tiros Hunts Hurricanes

A *Tiros III* meteorological satellite was launched successfully July 12 by NASA, with both the *Thor Delta* booster and satellite equipment functioning perfectly.

NASA officials said that the satellite's orbit—designed to gain new information on hurricanes—has an apogee of 450 miles, a perigee of 425 miles and an inclination of 48 degrees, 100 minutes.

The satellite differs from its two predecessors, *Tiros I* and *II*, in that it carries two wide-angle television cameras and a new infrared radiation experimeent.

A new tracking station at Santiago, Chile, is also being used for the first time in the *Tiros* Program.

The satellite transmitted good pictures of cloud cover on its first pass over the earth.

Swedish Order Bloodhound

BRITISH BLOODHOUND Mark 2, shown at operational site, has been ordered for Swedish air defense in "large" contract.

AF Overhauls Staff

The Air Force has announced a major reorganization of the Air Staff, effective July 1.

The new posts:

Deputy Chief of Staff (Systems and Logistics)—a combination of staff responsibilities for development, procurement and logistic support of aircraft, missiles, space and electronic systems. To be under Lt. Gen. Mark E. Bradley.

Deputy Chief of Staff (Research and Technology)—Assigned to Lt. Gen. Roscoe C. Wilson, will combine staff action on research, advance technology, studies requirements and development planning.

Other assignments:

Brig. Gen. Milton B. Adams—supervise development, procurement production and review all systems programs at staff levels.

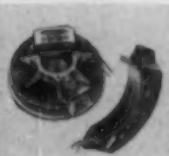
Maj. Gen. William T. Thurman—Director of procurement management, responsible for major policy and procedure in field procurement agencies.

Brig. Gen. M. C. Smith—Director of systems services for the S&L Office. Responsibilities include: missile range and special group environment support; standardization and engineering; tech and industrial reports and general equipment support.

System staff offices (SYSTO's) will be set up for systems such as *Minuteman* and B-70, and will report directly to Asst. DCS/Systems. Units will exist only during the critical phase in the system's life cycle.

Up to 262,000 counts per revolution

Up to 32,000 counts per revolution


Lightweight Airborne Model Up to 32,000 counts per revolution

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Performance:

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- Forward and backward rotation counts
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Typical Applications:

- Precision machines — servo control
- Pulse tachometers
- Shaft position control and monitor
- Circle dividing
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DCS/R&T will be the AF focal point for scientific and tech interaction with agencies such as AEC and NASA.

Esenwein to Lead AIA

August Esenwein has been elected president of the Aerospace Industries Association, replacing Gen. Orval Cook, who will resign in December. Esenwein, retired Convair Executive Vice President, will assume the title of Deputy General Manager of AIA on Oct. 1, pending his succession to the presidency.

AMR Communications Growing

A 700-mile extension of the Atlantic Missile Range underwater communications net will be built by the team of U.S. Underseas Cable Corp., Phelps Dodge and Northrop, with USUCC overall manager. When finished, the $5-million Air Force Missile Test Center project will be capable of providing 60 4-kc channels in two directions. Work is scheduled to be completed in 26 months.

Another Discoverer Snatched

Fourteen minutes after first sighting, the *Discoverer XXVI* capsule was safely air-snared north of Hawaii July 9 by a C-119 Flying Boxcar. The fourth successful air recovery in the series came after 32 orbits, some 50 hours and 36 minutes after launch from Vandenberg AFB.

Originally it was hoped to leave the capsule in orbit four days. "Technical reasons" forced scientists to trigger the return mechanism early.

The capsule carried samples of silicon, iron, bismuth, yttrium, magnesium, nickel, lead and uranium. The silicon samples may provide information on damaging effects of radiation on solar cells. After recovery, *Discoverer XXVI* was flown to Sunnyvale, Calif., for study and evaluation.

New Bullpups Upcoming

A $2.25-million AF contract was awarded The Martin Co. for initial production of the nuclear-tipped *Bullpup* GAM 83-B. The air-to-surface weapon has "offset launch" ability, which permit the pilot to guide it towards targets lying at extreme angles from line of launch.

Certified Leakproof for Helium at 6000 psi

"No leakage or media migration was noted during or at the completion of 500 cycles of operation" with a ¾-inch CPV O-SEAL globe valve handling helium at 6000 psi.

So reports the Wyle Laboratories of El Segundo, Calif. on an independent test — one of many that underlines the leakproof reliability of CPV O-SEAL valves. But that is only a part of the story.

The unique O-SEAL SYSTEM includes a complete line of unions, elbows, tees and fittings in addition to globe, check and relief valves that can be installed, removed or relocated with hand tight connections. Positive, leakproof service is assured. Sizes range from ⅛-inch to 2 inches.

Send today for a copy of the complete Wyle test report and 36-page Catalog 60-B on the CPV O-SEAL SYSTEM.

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Atlas Succeeds, Sets Mark

The trouble-plagued *Atlas-E* whizzed to a new distance record for military flights—9050 miles. The Canaveral-Indian Ocean trip on July 7 beat by 10 miles two earlier *Atlas* flights, and was the first long-range success for the *E*, which had failed in 7 of its 10 previous launchings.

After the flight, a General Dynamics spokesman said he hoped the shot marked the end of the missile's problems.

The Air Force hopes to have the bird operational late this year.

Rover's Clogged Plumbing

Some 100 plumbers and pipefitters walked off the job June 30 at the Project *Rover* test site northwest of Las Vegas.

AEC officials claim the walk-out will delay testing of the nuclear rocket program. Union leaders say their members want 5 cents an hour more than management's proposal of a 45-cent hourly raise, spread over a two-year period.

Spectre of Red N-Bomb

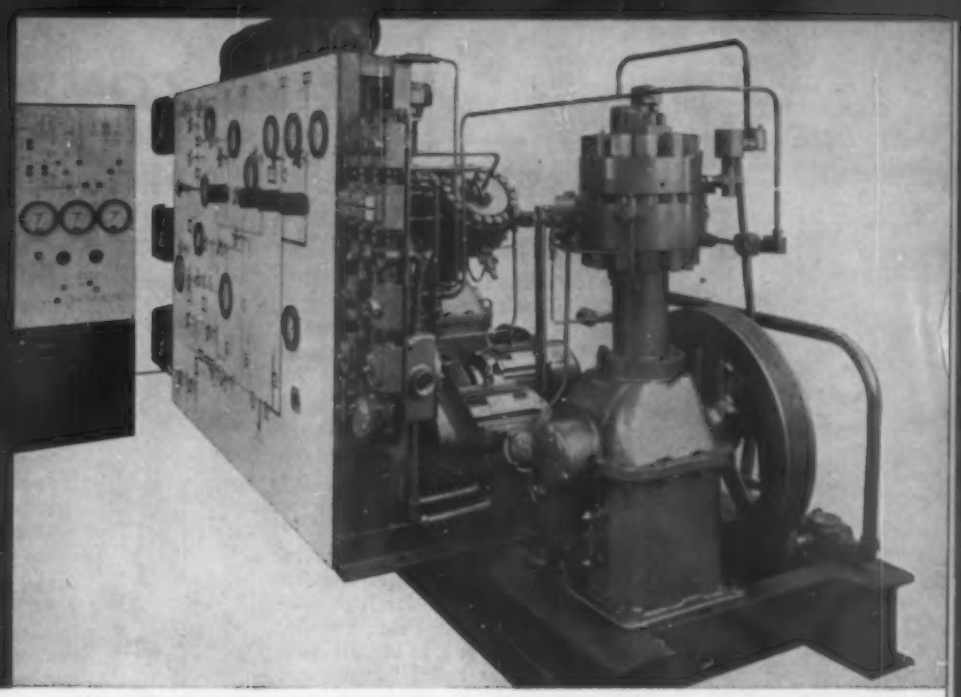
Russia may have beaten the U.S. in developing a neutron bomb and may use it in a Berlin showdown, Sen. Thomas Dodd (D-Conn.) warned in U.S. News & World Report. Said Dodd: "If they (the Russians) have violated the 2½-year honor moratorium on testing—and to my mind they would not be communists if they had not cheated on it—then they already may have beaten us to the neutron bomb."

The Congressional Atomic Energy Committee will meet later this month to discuss among other things the issues President Kennedy faces in deciding whether to resume nuclear testing.

Indemnity Ceiling Removed

The House Space Committee approved a bill (HR 7115) granting NASA authorization to indemnify space contractors against "unusually hazardous risks," after removing a $500-million government liability limitation (M/R, June 12, p. 44).

The committee approved a subcommittee's recommendation to lift the limitation on grounds that the federal government has no authority to impose limits on court cases within individual states.



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LET AMINCO engineer and construct your gas pressurization system . . .

Over the past several years AMINCO has supplied gas pressurization equipment for practically ALL the major high pressure shock tube facilities in this country, AND FOR GOOD REASON:

1. Compression is accomplished with complete freedom from contamination, through use of Corblin diaphragm-type compressors which Aminco handles exclusively in North America.
2. Valves, fittings, tubing, pressure vessels, are of the highest caliber, built with the know-how that 40 years' experience in the field assures.
3. Every precaution is taken to assure the safety of operating personnel.

THE SYSTEM ILLUSTRATED ABOVE

Illustrated above is a shock tube pressurization system recently constructed by Aminco for a major aircraft company. The system is designed for pressurization of a large 15,000 p.s.i. system. It includes three Corblin diaphragm-type compressors (two shown); manual and automatic controls for pressurization and firing of the shock tube; a medium-pressure gas-mixing vessel (not shown); and a high-pressure gas-storage vessel (not shown).

In operation, either a helium-hydrogen mixture may be taken from the gas mixing vessel at elevated pressure for further pressurization, or air may be taken at atmospheric pressure for pressurization.

Gas is pumped at 9,000 p.s.i. into the high pressure storage vessel whose volume is about double that of the shock tube driver section. Suction is taken from the high pressure storage vessel, by two high-pressure booster compressors, for pressurization of the driver section. Pressurization can be accomplished within 11 minutes to 15,000 p.s.i.

A remote control panel is provided for filling the driver section with oxygen; pressurization of the driver section; and firing the shock tube.

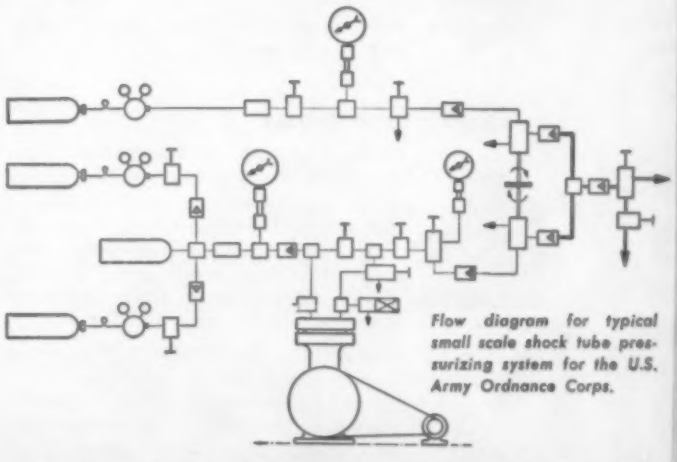
AMINCO

CORBLIN COMPRESSORS

Corblin diaphragm-type compressors are particularly well suited to this type application since they permit pressurization of gas directly from bottles, and their non-contaminating qualities make possible the obtainment of radiation measurements, etc. from shock tube experiments. They are leak-free . . . less expensive to maintain . . . feature high efficiency for less power cost.

SEND FOR NEW BULLETIN 4074 K-2

A new 8-page bulletin will be mailed on request. Four models of Corblin compressors are described for pressures to 30,000 p.s.i. and capacities to several hundred s.c.f.m. The bulletin also describes additional shock tube facilities; other gas-handling applications; and a complete line of Corblin diaphragm-type pumps. Aminco engineers will be pleased to visit your facility to discuss systems for shock tube pressurization or other high pressure gas handling applications tailored to your individual needs.



Flow diagram for typical small scale shock tube pressurizing system for the U.S. Army Ordnance Corps.

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INERTIAL COMPONENTS

SUB-SYSTEMS AND FLIGHT TEST EQUIPMENT

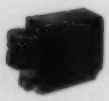
RATE GYROSCOPES

TYPE M-100 is the latest in Honeywell's family of miniaturized high performance rate gyros. It features constant damping over a wide operating temperature range (−65°F to +250°F) without the use of heaters.

TYPE GN or "Golden Gnat" is another of Honeywell's high performance gyros and has been in full production in a wide variety of miniature rate packages over the past four years.

TYPE JR, another rate gyro of proven reliability, features a unique quadrilever spring suspension for high sensitivity and a wide full range under severe environmental conditions; TYPE JRS, with Gimbal Torquer and SMRD self-check circuits plus thermostatically controlled damping system heaters, fulfills requirements for confirmed reliability and constant damping; TYPE K Rate Measuring Gyro features a linear output signal that is proportional to the input rate within 0.25% full scale.

INERTIAL SUB-SYSTEMS



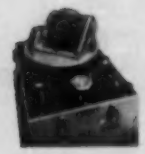
Roll, pitch and yaw rates are measured by special Inertial Sub-System Packages using Honeywell Gyroscopes. The polarity and amplitude of the output D-C signals correspond to input rates of turns. These output signals, teamed with other equipment, make possible uniform pilot control response for all flight conditions.

F102 PACKAGE, with three Model JR Gyros, is used in the F102 fighter.

F104 PACKAGE, designed around three Gnat Gyros, is used on the F104 Super Star Fighter.

F106 THREE-AXIS TURN RATE TRANSMITTER also uses three Gnats.

TEST EQUIPMENT



HONEYWELL RATE GYRO TEST SET designed for use by field personnel for the static analysis of rate gyros, rate gyro demodulator amplifier, and three-axis rate gyros packages. This equipment meets the design requirements of MIL-T-945 and environmental test requirements outlined in MIL-E-4970.

SPECIALIZED TEST EQUIPMENT such as Radar Range Servo Test Sets, Frequency Response Analyzers, and other electronic equipment can be designed and manufactured to meet your requirements.

ACCELEROMETERS

TYPES LA-100, LA-300 are low cost, rugged, linear, non-pendulous units with potentiometer outputs.

TYPE LA-200 is a miniaturized, pendulous, linear accelerometer which is fluid-damped and mechanically compensated. Output signal is provided by a variable reluctance signal generator.

TYPE LA-500 is a linear, non-pendulous, fluid-damped potentiometer output device that features constant damping, linear response, (−65°F to +175°F).

TYPE LA-600 is a linear, non-pendulous A-C accelerometer in which pick-off friction is eliminated to permit resolution of extremely low level inputs. This accelerometer features magnetic damping for near constant damping ratio (−65°F to +250°F).

TYPE LA-800 subminiature linear accelerometer is the smallest such instrument available today offering a variable reluctance pickoff and an essentially constant damping ratio over the temperature range of −65°F to +250°F.

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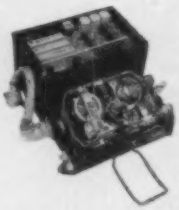
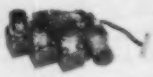


Honeywell's Boston Division will design from customer specifications or prototypes, or manufacture to customer's drawings. Typical of the completed programs in this area are: CN-100 Compass-controlled Stable Reference Platform for a bombing system (shown at left), and Displacement Gyros for the A1A/BNC Bombing Navigational Computer.



MARK 46 PACKAGE, containing three Gnats plus two pendulous accelerometers, supplies complete stabilizing data for the automatic pilot on the Mark 46 Torpedo.

POLARIS PACKAGE, with three Gnats and associated circuitry in a 5⅛" x 4" x 2 15/16" package, is the control rate of turn instrument in the Polaris Missile.

Write to Minneapolis-Honeywell, Boston Division, Dept. **18**, *1400 Soldiers Field Road, Boston 35, Massachusetts.*

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Military Products Group

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The entire Mercury system was designed around the safety of the astronaut. Perched atop his capsule is an escape system powered by a GCR solid-propellant rocket. It will hurl the astronaut—capsule and all—up and out of trouble should the booster fail during launch or low-altitude flight. This GCR rocket must work. It does work. In more than 60 test shots, it has fired perfectly every time. This super-reliable propulsion system is one of several important solid-rocket projects now in production at GCR. In propulsion system research and development, GCR is at work on advanced programs for huge segmented boosters, hybrid rockets, ultra-high performance propellants, and a variety of other promising projects. **GRAND CENTRAL ROCKET COMPANY**
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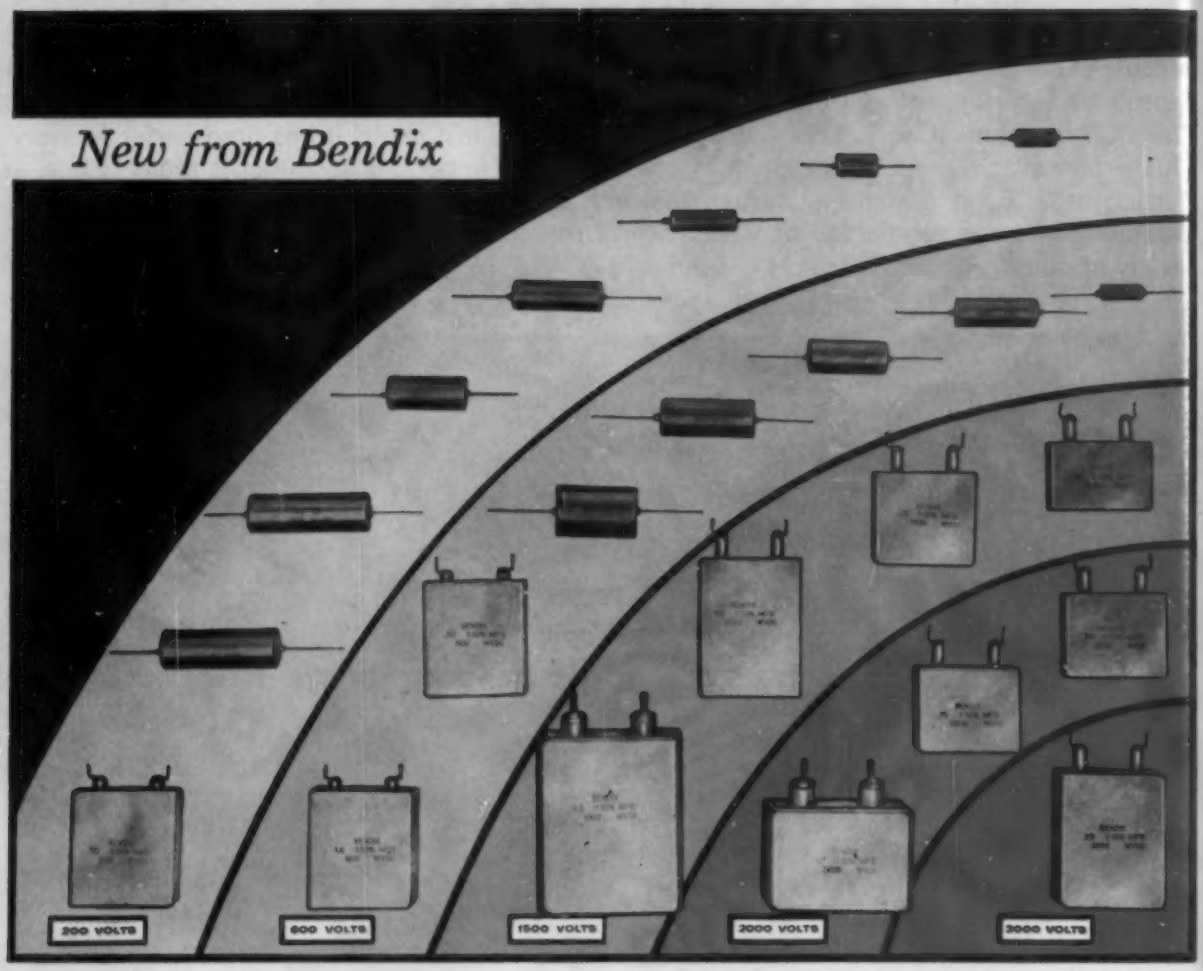

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Operable to +200°C.

The Bendix® E-200 series of lightweight, small size capacitors is designed for installations requiring a high degree of component reliability at operating temperatures as high as 200°C.

High temperature capability and mica-like electrical characteristics enable the E-200 series to withstand extremely high orders of AC in small envelope size at all ambients under 200°C.

The new series is designed and manufactured to a Bendix specification which is patterned after the high reliability specification MIL-C-14157B, proposed.

Hermetically sealed in tubular or rectangular housings, these capacitors offer superior resistance to mechanical and climatic environments.

E-200 CHARACTERISTICS: • Wound mica papers • Solid impregnants • Exceptional stability • High insulation resistance • Radiation resistance • Outstanding dependability

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NEXT: FLIGHT-WEIGHT ROCKET FIRINGS

Current achievements by the rocket propulsion industry give reassuring evidence of this nation's ability to seize the initiative in the development of large solid boosters.

The next advance of major significance to the national booster program will be the firing of flight-weight segmented rockets of 250,000 and 500,000 pounds thrust at UTC's Development Center.

UTC

UNITED TECHNOLOGY CORPORATION

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Capability backed by four decades of propulsion experience

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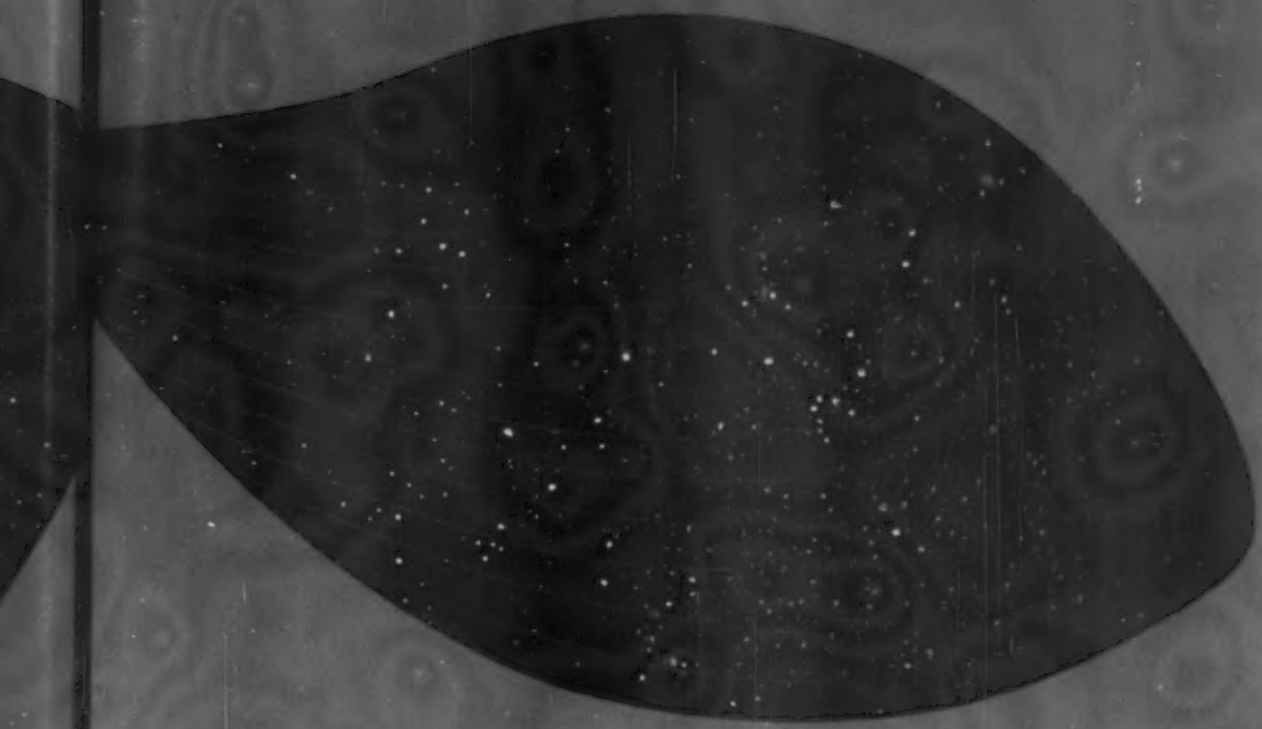
E = MC²



ACIN THE FOURTH DIMENSION IN PROPULSION DEVELOPMENT

Whether the universe has a "saddle shape," or any shape at all, is a matter of interesting conjecture. The matter of space travel, however, is the subject of intense experimentation. A nuclear/thermionic/ionic propulsion system, currently being studied at Lockheed Missiles and Space Division, might well become the power source for space vehicles.

Its design incorporates a nuclear reactor only one foot in diameter, generating heat at a temperature of 1850°K. This is transmitted to banks of thermionic generators, converting the heat directly into electrical energy for the ion beam motor which uses cesium vapor as a fuel. The entire system is designed without any moving parts, minimizing the possibility of failure.

Lockheed's investigation of propulsion covers a number of potential systems. They include: plasma, ionic, nuclear, unique concepts in chemical systems involving high-energy solid and liquid propellents, combined solid-liquid chemical systems. The fundamentals of magnetohydrodynamics, as they might eventually apply to propulsion systems, are also being examined. Just as thoroughly, Lockheed probes all missile and space disciplines in depth. The extensive facilities of the research and development laboratories—together with the opportunity of working with men who are acknowledged leaders in their fields—make association with Lockheed truly rewarding and satisfying.

Lockheed Missiles and Space Division in Sunnyvale and Palo Alto, on the beautiful San Francisco Peninsula, is an exciting and challenging place to work. For further information, write Research and Development Staff, Department M-24D, 962 West El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required. All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

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Systems Manager for the Navy POLARIS FBM and the Air Force AGENA Satellite in the DISCOVERER and MIDAS Programs

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Reaction controls at work in space — symbolized.

STEERING GEAR FOR MERCURY ASTRONAUTS

Conventional aircraft control surfaces will not guide space ships and capsules. Rudders, ailerons and elevators find no resistance and hence produce no reaction to their movements where there is no atmosphere. Even at altitudes only half way up, they are sluggishly ineffective.

The accepted answer to a dependable steering mechanism for astronauts is a system of jet reaction controls developed and produced by Bell Aerosystems Company. First used on Bell's own supersonic X-1B several years ago, the system has been greatly improved and adopted for the X-15, the Mercury man-in-space project and other space vehicles.

Through strategically located, low and high thrust (1 to 1500 pound) rocket engines, Bell's reaction controls not only position and guide the ship by controlling the roll, pitch and yaw, but they also provide for orbit changes and retro-thrust. Some of the jets are throttleable while others can be operated in combination to provide the astronaut positive and flexible control.

This revolutionary steering gear for space, available using monopropellants or high energy bipropellants, is just one of many advanced projects which are currently engaging the diversified talents of Bell Aerosystems Company in the fields of rocketry, avionics and space techniques. Engineers and scientists seeking challenging, long-range career opportunities can find them at Bell.

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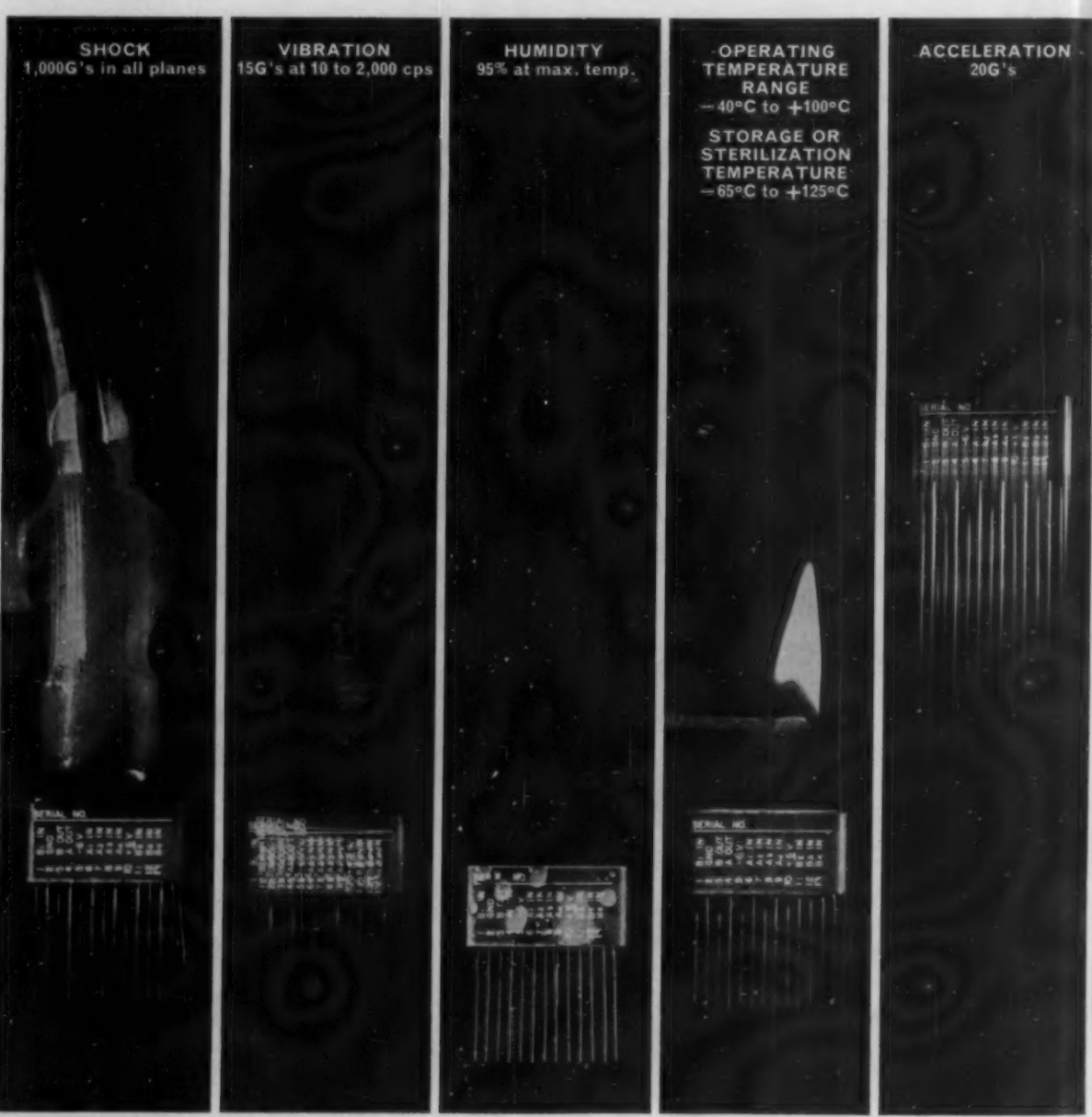
Delco Radio's new silicon digital modules operate on less than 4 mw. of power per logic stage. They are rugged enough to withstand extreme environmental conditions and are small and lightweight. Encapsulated in light foamy epoxy, each module weighs less than 12 grams and occupies less than one-half cubic inch. The basic set of modules includes a bistable multivibrator, a diode NOR gate, a power driver, a monostable multivibrator and an astable multivibrator. From these basic units larger computer subassemblies can be assembled, such as shift registers, adders, binary counters, decimal counters and timing devices. A range of applications—from small scale switching circuits to large computers can be satisfied with these modules. Environmentally proved to:



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men at work on a new approach to the stars

As principal instrumentation contractor for Project Rover, EG&G is already at grips with the central problems of nuclear propulsion for deep outer space exploration. A control, instrumentation and data acquisition system designed and operated by EG&G is of basic importance in the full-scale testing of Rover's KIWI prototype engines, designed by the Los Alamos Scientific Laboratory. The EG&G system is being effectively applied to the solution of problems of heat transfer, neutronics, fluid dynamics and general control.

EG&G instrumentation is also at work in the application of nuclear energy to industrial uses (Gnome) and in the international program for detection of nuclear explosions (Vela). In oceanography, EG&G equipment is probing the ultimate ocean depths. An informative brochure which describes the breadth and depth of EG&G's capabilities is available on request.

For information about employment prospects with this unique, vigorous organization write in confidence to Lars-Erik Wiberg. All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

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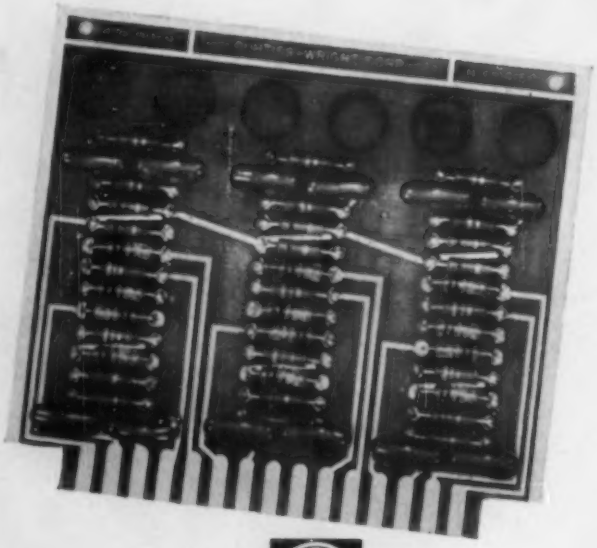

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Insulation news from Johns-Manville

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THE INSULATION WITH A LOWER CONDUCTIVITY THAN STILL AIR IS NOW AVAILABLE IN BLANKET AND TAPE FORMS FOR UNLIMITED NEW APPLICATIONS

Min-K, the unique insulating material developed and produced by Johns-Manville, now has an added quality . . . flexibility! Min-K is a new concept in missile insulation. The higher it flies, the better it insulates. Min-K's thermal conductivity drops as atmospheric pressure decreases. Its superior performance has been proved in hundreds of operational U. S. missiles.

New Flexible Min-K offers many special advantages. For example, it is the ideal way to lower prototype costs. You can test performance without the expense of special tooling. The flexible blankets lend themselves to bonding, lamination with reinforced plastics, service coatings and as a component of insulation systems. Further, Min-K can be tailor-made to wrap around a cylinder, cone or other geometric shape. And, it is also available in 1½" and 2" tapes for spiral winding on a duct or pipe.

Because of the added quality of flexibility, Min-K's unique insulating characteristics now can be used in virtually unlimited new applications. For full details on Flexible Min-K, Min-K and other J-M aviation insulations, write Johns-Manville, Box 14, New York 16, New York. In Canada: Port Credit, Ontario. Cable address: Johnmanvil.

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JOHNS MANVILLE JM PRODUCTS

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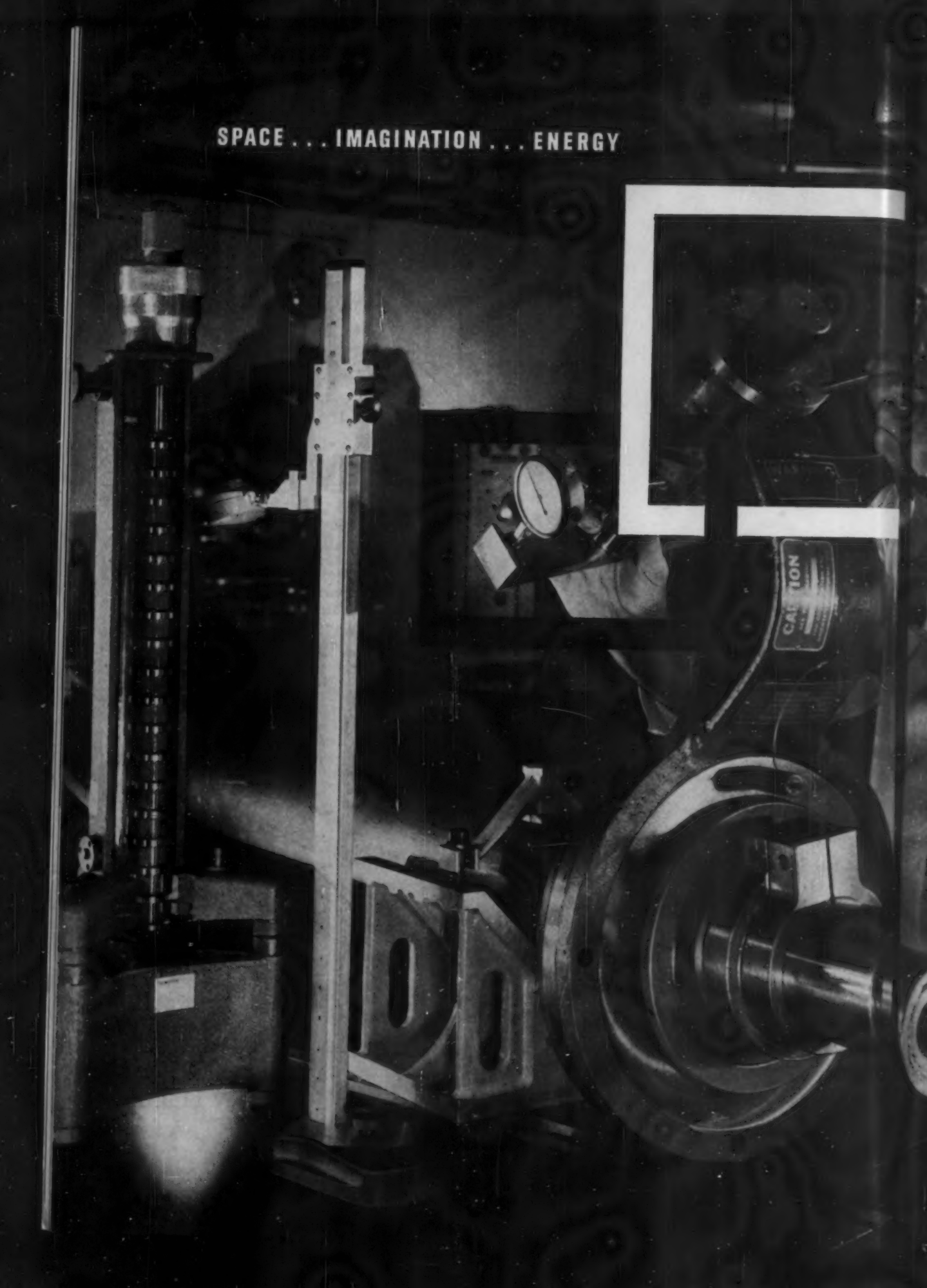
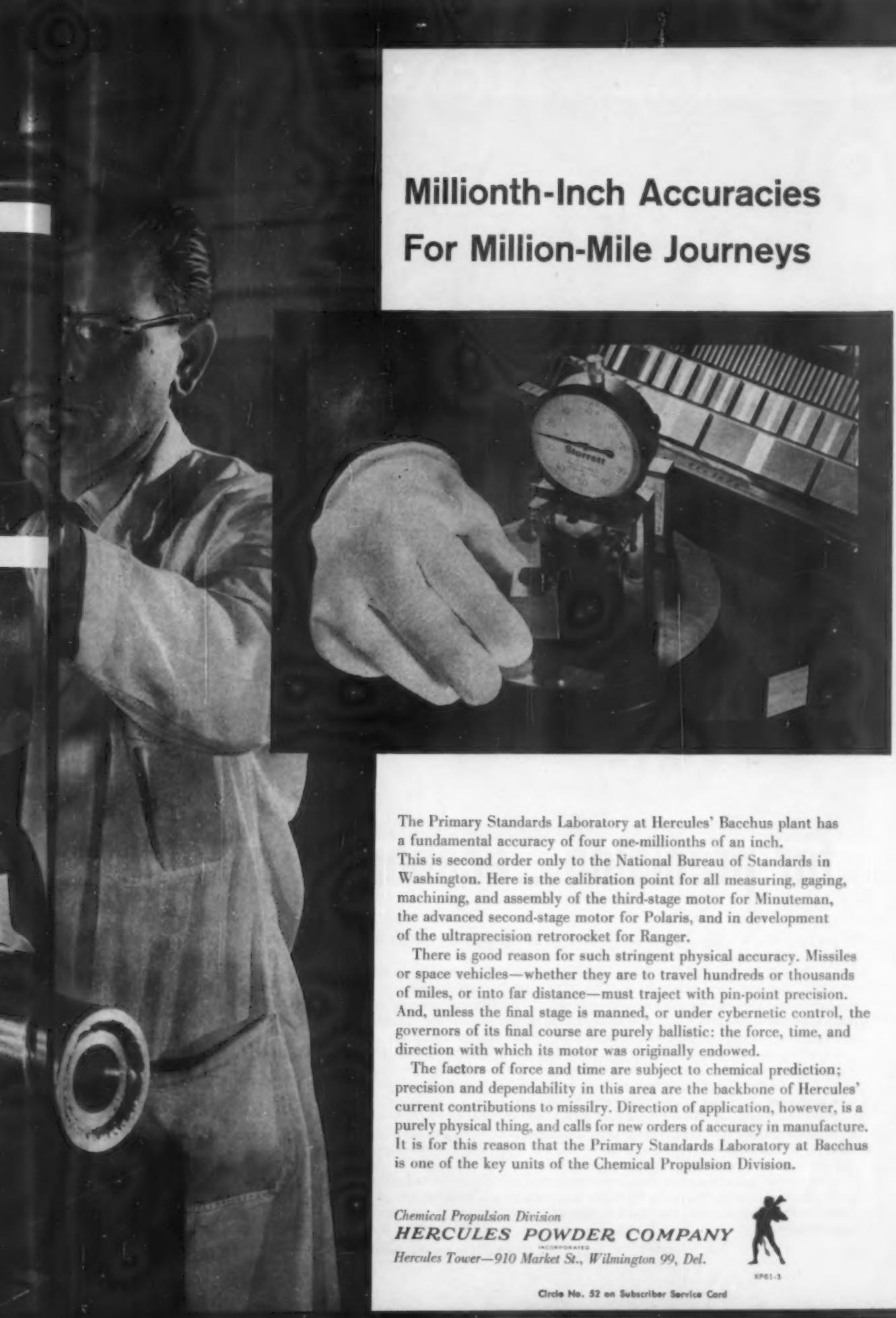

SPACE . . . IMAGINATION . . . ENERGY

Millionth-Inch Accuracies For Million-Mile Journeys



The Primary Standards Laboratory at Hercules' Bacchus plant has a fundamental accuracy of four one-millionths of an inch. This is second order only to the National Bureau of Standards in Washington. Here is the calibration point for all measuring, gaging, machining, and assembly of the third-stage motor for Minuteman, the advanced second-stage motor for Polaris, and in development of the ultraprecision retrorocket for Ranger.

There is good reason for such stringent physical accuracy. Missiles or space vehicles—whether they are to travel hundreds or thousands of miles, or into far distance—must traject with pin-point precision. And, unless the final stage is manned, or under cybernetic control, the governors of its final course are purely ballistic: the force, time, and direction with which its motor was originally endowed.

The factors of force and time are subject to chemical prediction; precision and dependability in this area are the backbone of Hercules' current contributions to missilry. Direction of application, however, is a purely physical thing, and calls for new orders of accuracy in manufacture. It is for this reason that the Primary Standards Laboratory at Bacchus is one of the key units of the Chemical Propulsion Division.

Chemical Propulsion Division
HERCULES POWDER COMPANY
INCORPORATED
Hercules Tower—910 Market St., Wilmington 99, Del.

XP61-3

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...TAPED...

for precision...economy...reliability

You're looking at a tape-programmed jig borer at the Sperry Farragut plant in Bristol, Tennessee.

Part of one of the country's largest such machine tool installations, its output is devoted exclusively to the economical production of precision mechanical and electromechanical components . . . reliable components of intricate control systems that guide many of the nation's successful missile and satellite "shots" and that will guide SATURN space explorations.

Advanced machine tools of this type are typical of Sperry Farragut's modern production facilities, which include one of the most extensive and up-to-date "clean room" areas for precision assembly work, and comprehensive equipment for product environmental evaluation.

At Sperry Farragut, full realization of equipment potentialities is assured by a highly trained staff with wide experience in guidance system production —skilled personnel motivated by a sense of urgency and dedicated to achieving the highest quality and reliability attainable.

Contracting agencies and government contractors are invited to talk over application of Sperry Farragut facilities and capabilities to their specific projects. Our liaison engineers will welcome an opportunity to discuss your requirements. O.S

Capabilities and facilities for study, design, evaluation, prototype construction, and final quantity production of precision systems, subsystems, and components for:

- *Missile guidance and control*
- *Fire control*
- *Aircraft instrumentation*
- *Navigation—land, air and sea*
- *Computers*
- *Trail marking equipment*

SPERRY FARRAGUT COMPANY

DIVISION OF SPERRY RAND CORPORATION

BRISTOL, TENNESSEE

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A lot of jobs—especially in missiles—need room to complete. It takes inner space to prepare for outer space. It takes skills and long experience to work with metals in the large way some of your jobs require.

General American's Plate & Welding Division has the space, the skills and the experience you need, whether your problem is one or a dozen special pieces, or a continuous operation involving thousands of units.

General American has produced lox vessels, radiation shields, atomic waste evaporators and missile equipment components. We are known around the world for the tanks we have fabricated and erected—tanks for storage of petroleum products, acids, chemicals and water; tank cars for transportation of any kind of liquid. We are constantly at work on projects that involve cutting, forming, milling and stress relieving of large metal structures. Our background in aluminum and alloy steels is considerable.

When a job requires custom fabrication of metal—any metal—we generally can handle it faster and better than any one else. We would like to work for you.

Plate & Welding Division

GENERAL AMERICAN TRANSPORTATION CORPORATION

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"FORMIDABLE DETERRENT"

OVER

ON

UNDER THE SEA

Vital insurance for the survival of our country is the quick detection of hostile undersea activity and immediate retaliation with a devastating counterblow. Only the maximum in detection and retaliation from over, on and under the sea will insure the necessary "formidable deterrent". Years of research and development by Philco Corporation are contributing to the solution of the country's many underwater problems.

Government and Industrial Group, Philadelphia 44, Pennsylvania

COMMUNICATIONS AND WEAPONS DIVISION • COMMUNICATIONS SYSTEMS DIVISION
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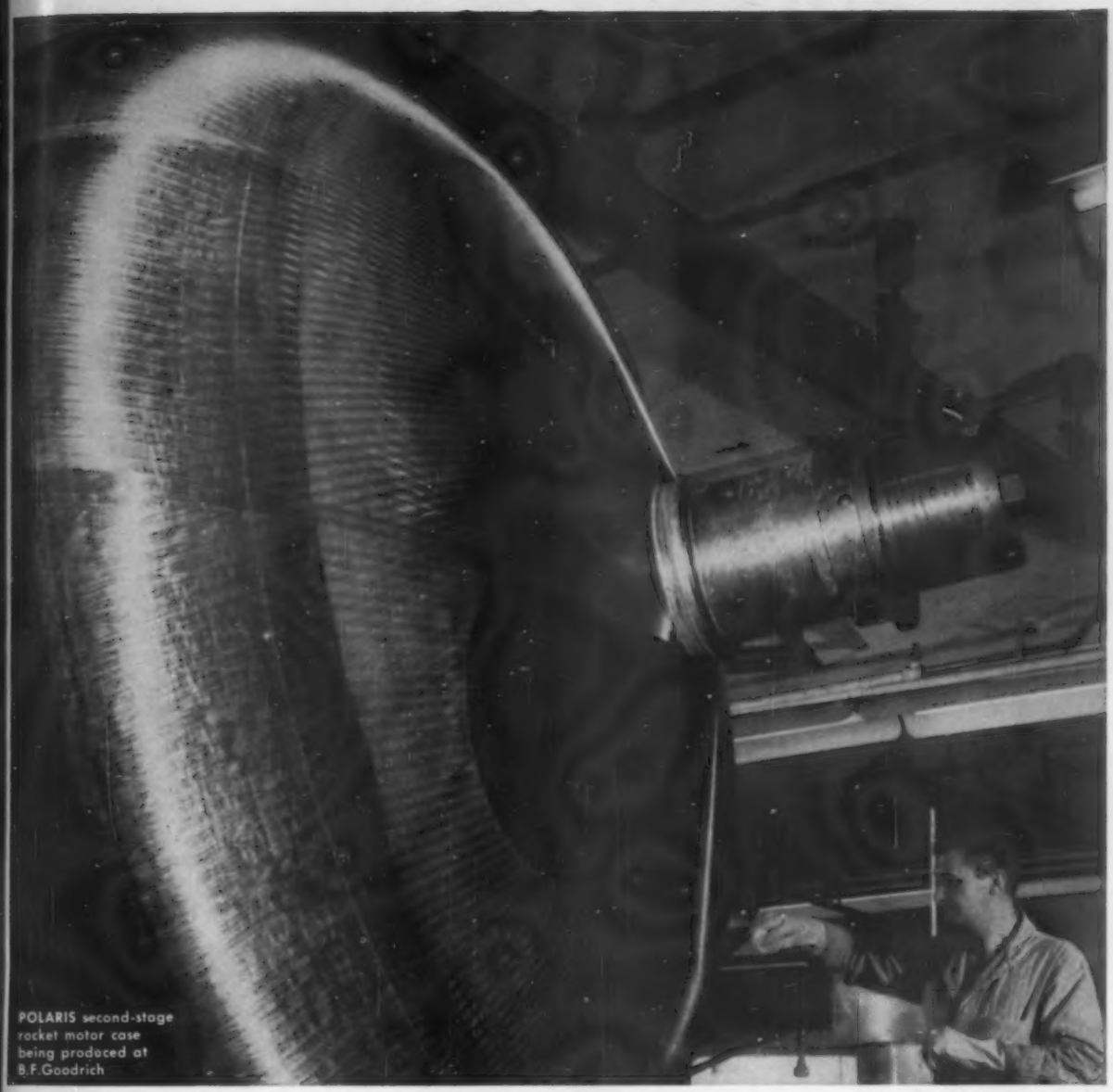

POLARIS second-stage rocket motor case being produced at B.F.Goodrich

B.F.GOODRICH OFFERS COMPLETE CAPABILITY IN FILAMENT-WOUND ROCKET MOTOR CASES

At BFG the ingredients for successful production of filament-wound plastic-impregnated glass fiber structures are:

- An active BFG development program for resin systems, backed by years of research in rubber and plastics chemistry.
- A pilot plant program for producing glass fibers with superior properties.
- Years of experience in unidirectional filament construction.
- A machine design group which engineers the production equipment for this new technique.
- Facilities for producing the complete structure, including insulator liner, at one location.

This *complete* capability can help you in designing and producing light, strong, heat resistant structures...for rocket motor cases, nozzles, and pressure vessels. For booklet describing the filament winding method, write *B.F.Goodrich Aviation Products, a division of The B.F. Goodrich Company, Dept. MR-7, Akron, Ohio.*

B.F.Goodrich **aviation products**

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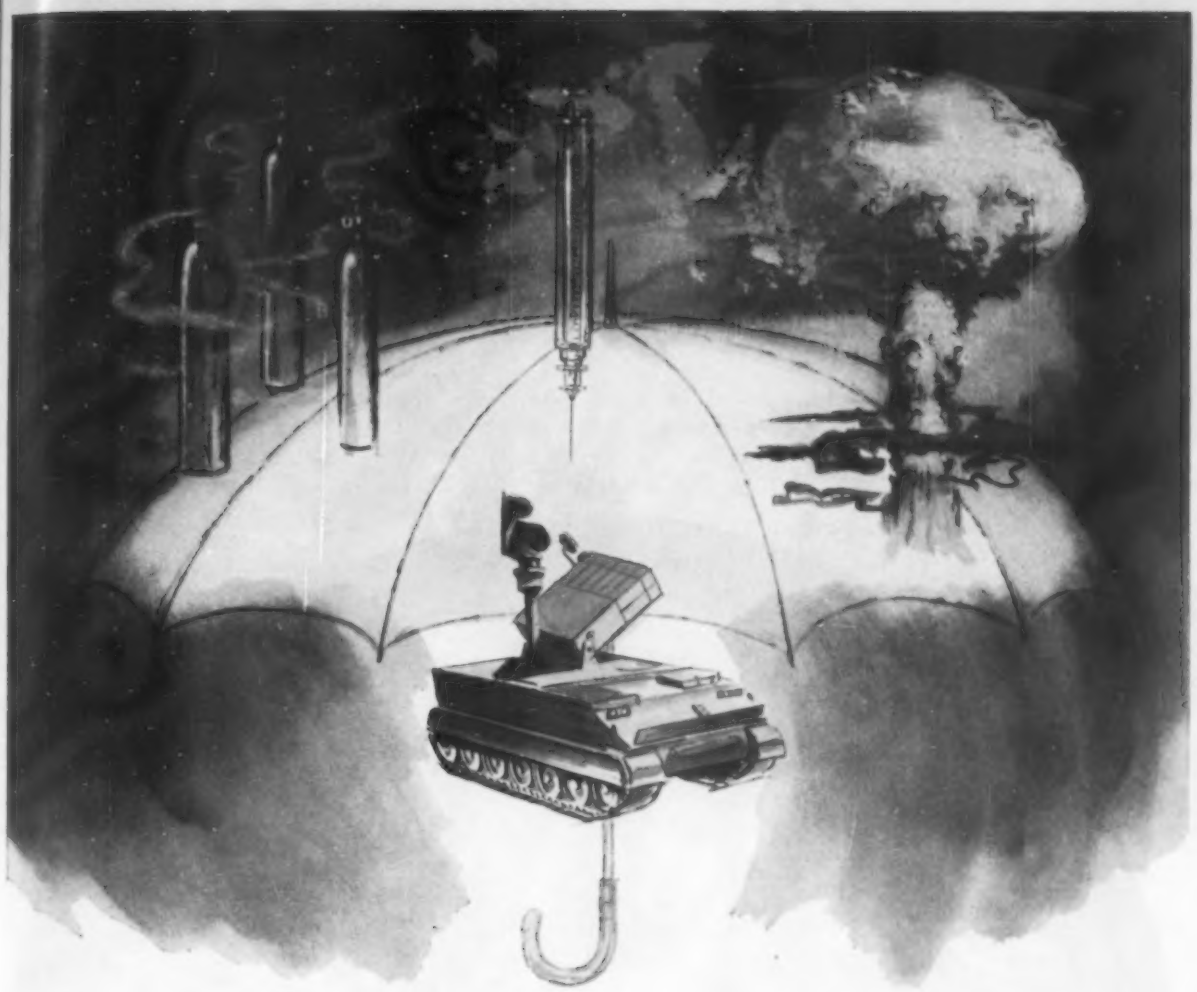
Circle No. 56 on Subscriber Service Card

Target in 14 countries

The target is a Northrop drone. The countries using it are Belgium, Canada, Denmark, Great Britain, Iraq, Italy, Japan, Nationalist China, Netherlands, Portugal, Republic of Korea, Spain, Sweden, and West Germany. Northrop target drones and missiles, surveillance drones, and complete support systems are built by **RADIOPLANE** A DIVISION OF **NORTHROP**



BATTLEFIELD PROTECTION AGAINST C-B-R ATTACK

Protecting troops under fire obviously becomes an infinitely more complex problem when that attack might possibly involve Chemical, Bacteriological or Radiological warfare; calling for special detection apparatus, filtering equipment, and decontamination systems. A team of FMC design engineers is now working on this problem, applying our company's considerable experience in chemicals and in machinery. If you have an upcoming project in this field, call in FMC at the planning stage.

For details, write Preliminary Design Engineering Dept., FMC Ordnance Division, P.O. Box 367, San Jose, Calif. Phone: CYpress 4-8124.

Putting Ideas to Work

fmc

FOOD MACHINERY AND CHEMICAL CORPORATION

Ordnance Division

1105 COLEMAN AVENUE, SAN JOSE, CALIF.

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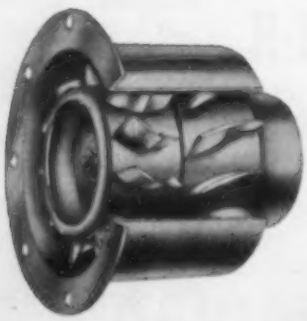
This slotted-blade vaneaxial fan design represents one of many special fan models available at Electric Boat Division for applications where small size, light weight, long maintenance-free life and low structure-borne vibration are critical factors □ At lower speeds and with smaller tip diameters than conventional fans, these turbo-slot fans produce the same air flow and pressure rise by controlling the flow of air over the surface of the rotating air-foil □ Lower speeds extend the service life of the vaneaxial fan and reduce the airborne noise and structure-borne vibration levels □ Smaller tip diameters allow for light-weight design and further contribute to lower airborne noise levels □ Call New London, Conn., Hilltop 5-4321, Ext. 1933, or write Fan Dept. (MR), Electric Boat, Groton, Conn.

ELECTRIC BOAT A DIVISION OF GENERAL DYNAMICS GIIIIIIIID

NEW FROM ELECTRIC BOAT

TURBO-SLOT FANS FOR MISSILES & SUPPORT EQUIPMENT



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TOUGH NUT?

TAKE YOUR MATERIAL PROBLEMS TO 3M MISSILE INDUSTRY LIAISON

3M's Missile Industry Liaison is the one-stop Information Center for the missile and design engineer. Staffed by technical personnel experienced in rocket propulsion and other phases of "missilery," it makes a definite point of knowing "who's doing what" in 3M. Whether you are concerned with a specific product application or a general field of activity, MIL is well qualified to translate your problems to those 3M specialists in your field of interest. Let MIL serve as your guide to 3M Divisions and staff laboratories.

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Adhesives and Sealers
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For further information, write: MIL Group, 3M Company, 900 Bush Ave., St. Paul 6, Minn.

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...WHERE RESEARCH IS THE KEY TO TOMORROW

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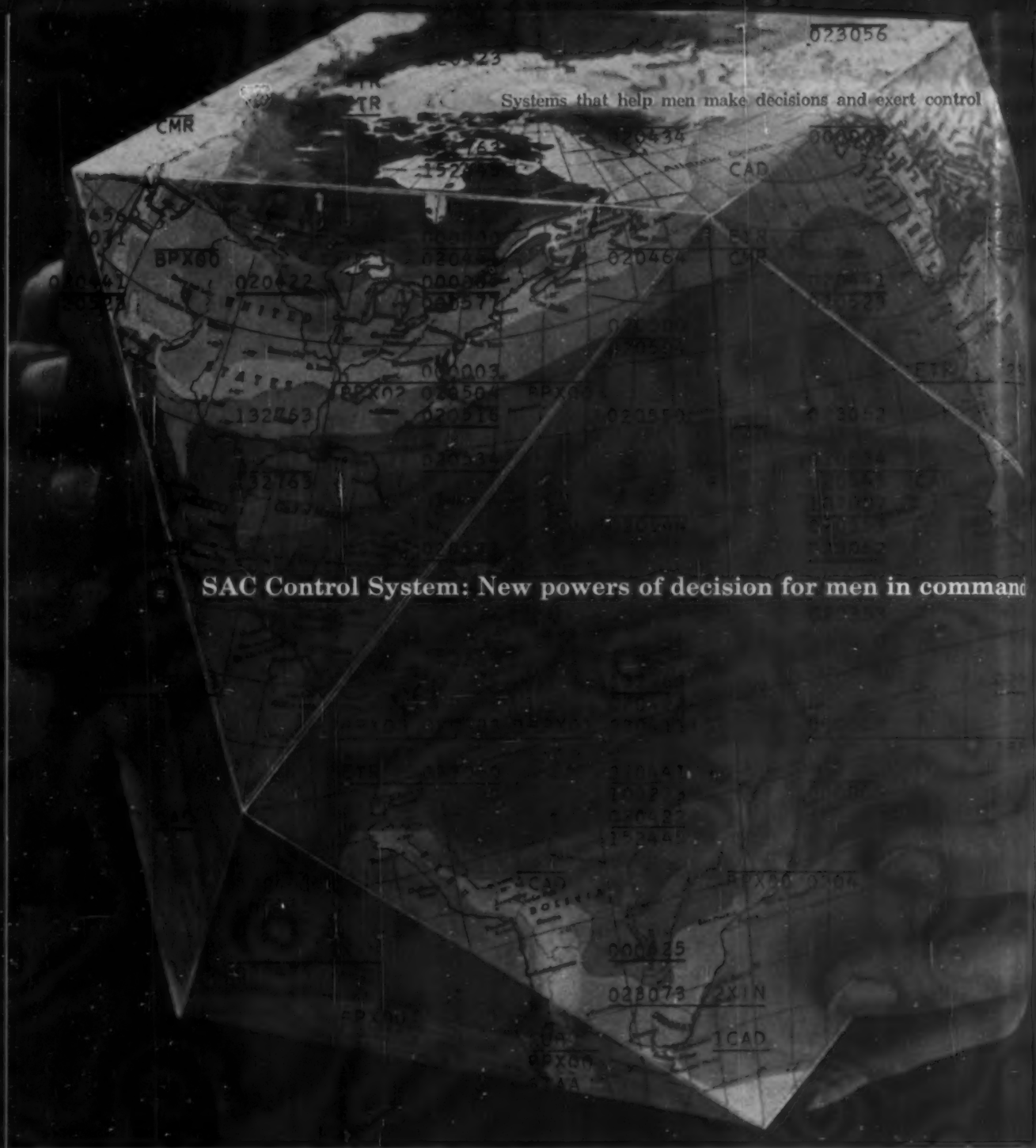
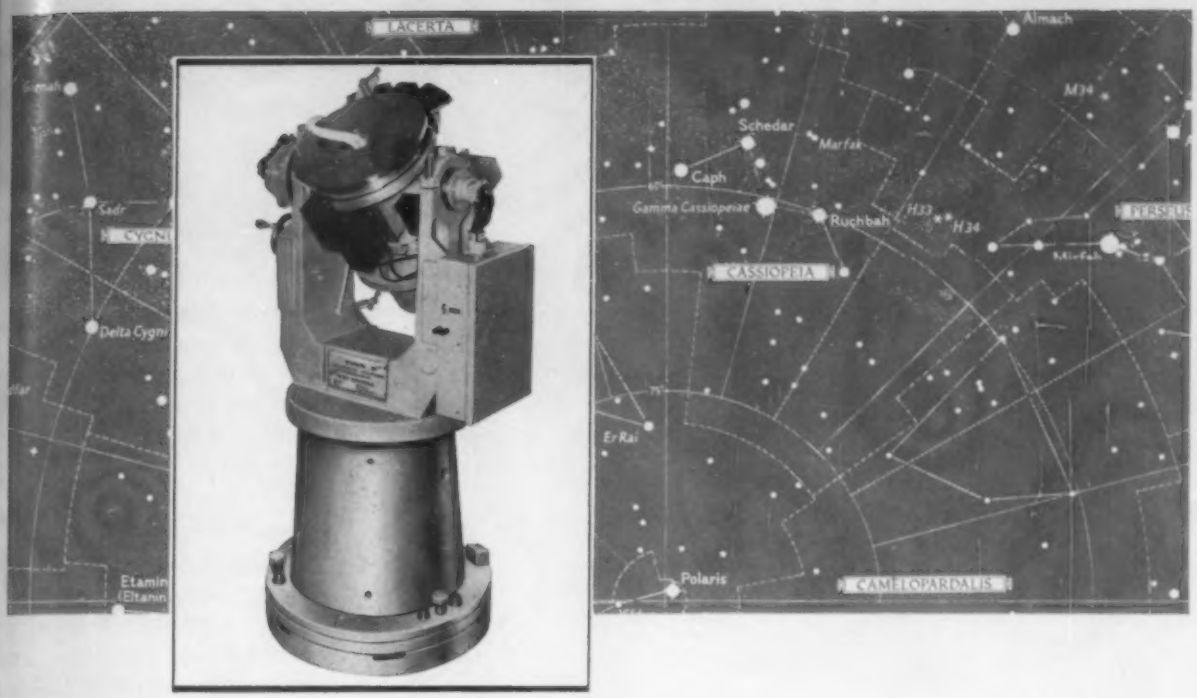


This world-wide communication network will help Strategic Air Force leaders exercise command and control almost in response to events of the moment. Yet the forces involved are dispersed throughout the world, the volume and complexity of information unprecedented. ¶ The SAC Control System will be a product of the new technology of automated information processing assistance. We have helped create this new technology, beginning with our work on SAGE. In projects such as SAACS and SAGE, we perform system analysis, information processing system design, and training of personnel in system use. And as a continuing effort, we carry on research into future generations of these control systems.

Scientists and engineers interested in joining an interdisciplinary approach to system development are invited to inquire about our rapidly expanding efforts. Positions are open for Operations Research Scientists, Computer Programmers, Engineers, Human Factors Scientists at our Santa Monica, California, Lexington, Massachusetts, Washington, D. C., and Paramus, New Jersey facilities. Please address Mr. R. L. Obrey, SDC, 2433 Colorado Avenue, Santa Monica, California. All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

SDC
SYSTEM DEVELOPMENT CORPORATION

The globe shown is the Dymaxion projection by R. Buckminster Fuller. It depicts the spherical world as a flat surface with a minimum of distortion.



Dunn Engineering

AIR BEARING TEST TURNTABLES

. . . A Major Breakthrough in the State-of-the-Art of Gyro Testing

As a sequel to the well-known Dunn oil-bearing T818 table, the Dunn T900 makes possible for the first time performance evaluation of inertial grade gyros having drift rates of the order of .001°/hr. Advances in the design of the T900 table drive and rate read-out provide precise table rotation and digital information.

The Inherently Compensated Air-Bearing Design eliminates the bearing flutter problem, and makes possible bearing stiffness of the order of 5,000,000 pounds per inch, thus limiting table top deflections to fractions of arc seconds. Use of air bearings provides zero stiction, minimal viscous drag, and eliminates mechanical bearing frictional uncertainties, permitting rate deviations no greater than 0.003°/hr. at frequencies of less than 0.1 cps. Orthogonalities are 5 seconds or less, and table axis angular wobble is less than 1 second of arc.

This new table represents the most advanced stage of the inertial guidance system testing field. Other fluid-bearing tables are available... write for data sheets.

DUNN ENGINEERING *CORPORATION*
CAMBRIDGE 41, MASSACHUSETTS

- advanced electronic systems
- inertial products
- test facilities engineering

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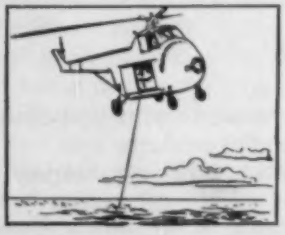
Wire

A LINK WITH THE PAST

Remember when you and kids in the neighborhood used to hook up a couple of tin cans with string and communicate from across the street? It wasn't fancy but it worked. Today, when uninterrupted communication between moving or fixed stations is so essential, Vitro has developed a link as simple and reliable as the old tin can technique. Nothing fancy, just a fault-free wire link system that assures maximum protection against such factors as outside interference, abrasion, jamming and foul weather conditions. Light weight packaging and snarl-free payout combine to make the wire link system, perfected by Vitro, as versatile as it is reliable. ■ In today's troubled world we're no longer playing games, but two lessons we learned from tin cans – simplicity and dependability – are still a very real concern in station-to-station communications.

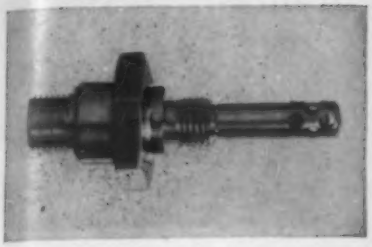


Vitro LABORATORIES

Division of Vitro Corporation of America

SILVER SPRING, MD. • WEST ORANGE, N. J. • EGLIN AFB, FLA.

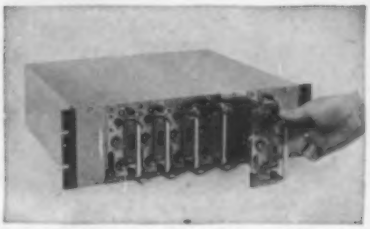
Temperature Transducer



Small probe-type device for high and low temperature applications where high pressures and severe flow conditions are imposed. Precise liquid or gaseous measurements to 800°F. Tiny sensing element of deposited platinum film allows high base resistance, extreme linearity, wide range capability, and fast response. Approved for ICBM environments.

Microdot Inc., 220 Pasadena Avenue, South Pasadena, California.

Transducer Signal Conditioning



Two new transducer and strain gage signal conditioning units feature radically different packaging concept at low cost per channel. Both the PS-290 Power Supply and PB-290 Power and Balance Unit incorporate plug-in card circuits for up to eight channels in a 19" rack, 5¼" high. Bridge completion balancing, and calibration resistors are easily accessible from the front. Output ripple is less than 500 microvolts peak-to-peak, or 200 microvolts RMS. Line regulation is less than 0.02%. Isolation is less than 0.01 microamps of 60 cycle current. Output impedance is less than 0.05 ohm.

Microdot Inc., 220 Pasadena Avenue, South Pasadena, California.

Circle No. 62 on Subscriber Service Card

VHF-UHF TRANSMITTERS

Proved in history's most demanding environmental laboratory — outer space — the custom designed unit shown above is typical of the development skill and production capability available from Microdot. The unit shown in miniaturized, pressurized, and features a solid state power supply that cannot be damaged by input/output overloads. Units are available in a complete range of modulation — CW, FM, Phase, and Pulse, with frequency coverage 100 to 5000 mc/s and output from 100 mw to 10 watts.

Telemetry Capabilities at Microdot have been dramatically expanded with the recent acquisition of Spectralab Instrument Company. The highly regarded development skill, production capability, and working experience of Spectralab in the field of VHF and UHF cavities and related instrumentation is available from Microdot's Instrumentation Division. This equipment, outstanding in its attention to miniaturization and ruggedness, is a vital part of such important projects as Pioneer V, Jupiter, Atlas, Pershing, Redstone and Echo I.

UHF Telemetry Transmitters, Models 2406 and 2409, use a unique, automatically stabilized circuit, with the output frequency referenced directly to a quartz crystal. This approach allows a greatly reduced size compared to the multiplier chain conventionally required to achieve crystal stability, as well as increased reliability due to a fewer number of parts.

The transmitters have their own solid state power supply designed to provide a high ratio of rf output power to total power input. The frequency modulation circuitry is sufficiently linear to introduce completely negligible distortion to the modulation signal. For further information, Call Microdot or write for catalog sheet TT-1.

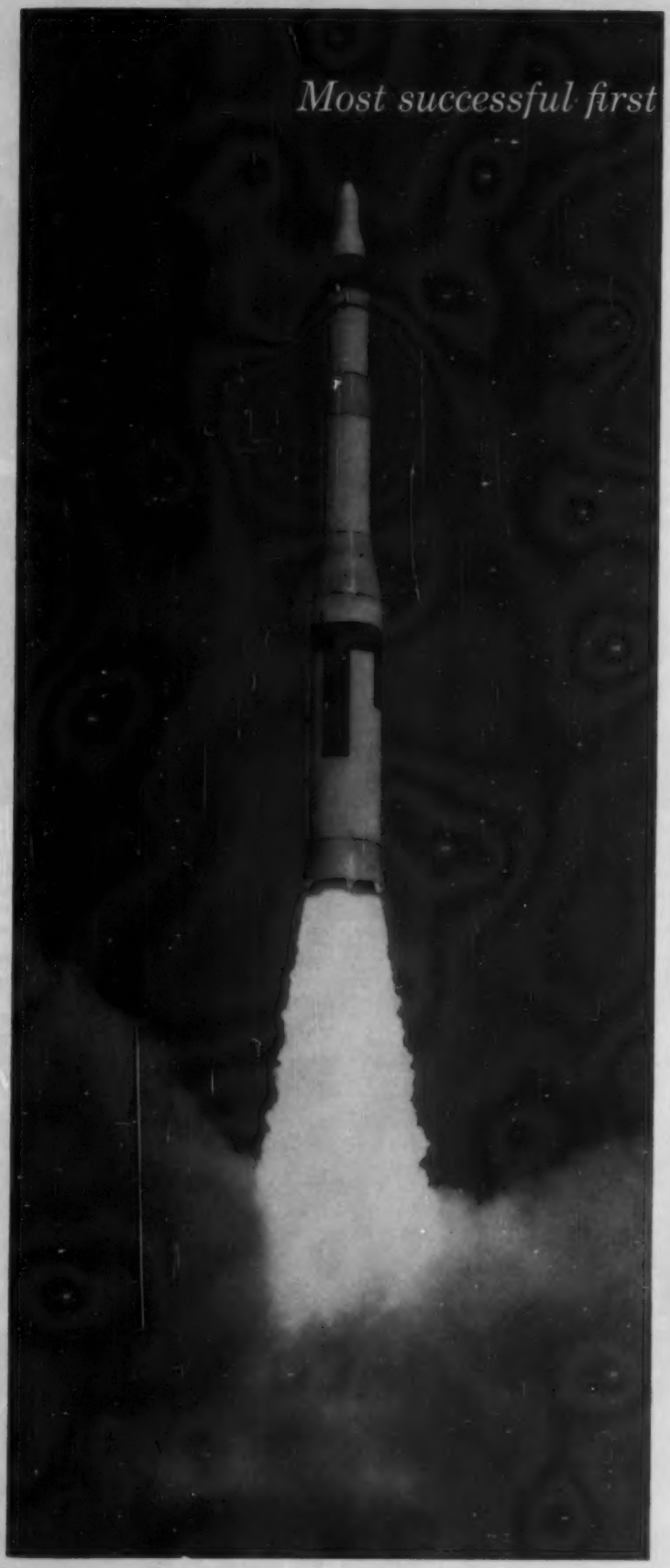
SPECIFICATIONS

Frequency Range:	
Model 2406	2200-2300 mc/s
Model 2409	1435-1535 mc/s
Frequency Stability:	±0.001%
Power Output:	10 watts
Power Output Stability:	1 db
Modulation:	PCM/FM, PAM/FM, FM/FM
Input Voltage:	28 vdc
Temperature Range:	-40°C to +70°C
Vibration:	10 g, 5-2000 cps
Size:	2⅛" x 7⅜" x 11"
Weight:	12 pounds

MICRODOT INC.

220 Pasadena Avenue, South Pasadena, Calif.

MUrray 2-3351 SYcamore 9-9171



Most successful first flight in missile history

Historic first firing of Minuteman, the U. S. Air Force's first solid-fuel intercontinental ballistic missile. Completely successful, this flight marked the first time in history that so many missile components were tested on initial flight: three rocket stages, full guidance system and nose cone. Compact, quick-firing Minuteman missiles, scheduled for operational status by mid-1962, will be stored ready for instant action in underground silos and on special trains. Boeing is responsible for Minuteman assembly and test, design and development of launch control and ground support systems.

Capability has many faces at Boeing

SKY TANKER. Boeing KC-135 jet tanker refuels bombers and fighters to provide greatly extended range. This versatile Boeing jet is also a military transport. The United States Air Force recently ordered 30 C-135s, cargo-jet version of KC-135.

TESTING. TESTING. Boeing electronic system tests effectiveness of radar and countermeasures systems. Boeing is widely active in electronics—in research, design, manufacture and test, and in the assembly of systems for Air Force's BOMARC and Minuteman missiles, and Dyna-Soar space-glider.

BOEING

CONVAIR/POMONA USES

DORSETT TELEMETRY COMPONENTS

Subcarrier oscillators designed and built by Dorsett Electronics are standard equipment in the FM telemetry systems of both the Advanced Terrier and the Tartar missiles, built by Convair/Pomona, Convair Division of General Dynamics.

The same high standards of electrical performance and quality workmanship that go into the telemetry components being delivered to Convair/Pomona are found in all Dorsett-built telemetering equipment. That is why more and more of the nation's missile and satellite builders are specifying Dorsett equipment.

For more information on the products and capabilities of this fast growing team of telemetering specialists, including the new facilities at Dorsett's West Coast Division—American Missile Products Co., Inc., write today.

DORSETT ELECTRONICS, INC.

P. O. BOX 862 • NORMAN, OKLAHOMA • PHONE JE 4-3750

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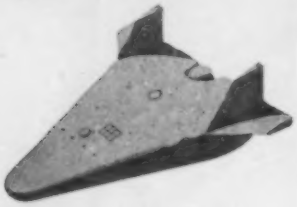
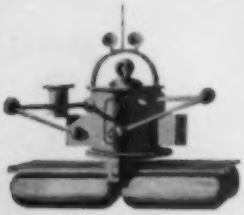
Lunar VTOL Vehicle. A rocket-propelled craft designed to collect lunar ore specimens.

Nuclear Space Ship. An unconventional desig.. by Douglas with living quarters around the ring at the bottom. On landing, it would ease down, ring first.

Nuclear Space Ship. A Douglas design for a space ship with crew quarters and control rooms in the nose, nuclear reactor in the rear.



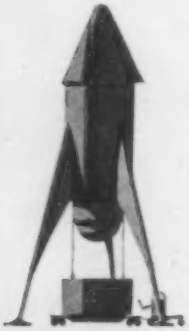
Supply and Escape Vehicle. A compact re-entry vehicle to supply orbiting space stations or to return crews to earth.



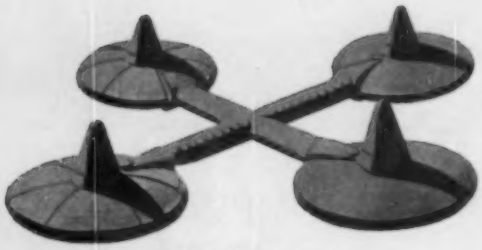
Lunar Service Vehicle. Travels like a "swamp buggy" on inflated rollers. Mechanical arms provided to handle outside chores.

Nuclear Space Ship. A future, medium-thrust, nuclear-electric space ship for one-year interplanetary round trips (Martian and Venusian).

Douglas Thor. Designed as a military IRBM, this dependable missile is the workhorse of the Space Age.



Lunar Cargo Handlers. Would load lunar ore samples into containers to be towed back to earth by rockets.



Space Observatory. Sections of this Douglas-designed space station would be sent into space in rockets and be joined together in orbit.

Lunarmobile. Donut-shaped exploration vehicle to use rocket power in space and tractor treads on the moon's surface.

Saturn. First U.S. vehicle designed to put tons of payload into orbit . . . or onto the moon. Douglas-built second stage is as tall as a 4-story building.

Eleven ways to outwit the law of gravity

When the Space Age dawned, Douglas was ready with specific proposals for space equipment either completed or in advanced stages of development. (Some appear above.)

These Douglas proposals were based on *realistic* estimates of the capabilities of men and materials. They are the valued dividends of the company's considerable experience, gained from the design and production of 30,000 missiles and rockets. These include the Douglas *Thor*, an IRBM which has been totally successful in 86% of its tactical and space firings over the past two years.

Today, Douglas looks ahead to other exciting challenges from its firm position of leadership in the conquest of Space.

DOUGLAS

MISSILE AND SPACE SYSTEMS • MILITARY AIRCRAFT • DC-8 JETLINERS • RESEARCH AND DEVELOPMENT PROJECTS • GROUND SUPPORT EQUIPMENT • AIRCOMBO • ASW DEVICES

He's solving a real estate problem

This AMF engineer's job is determining how best to move big missiles off shore for launching. Should they be floated out horizontally, flooded to an upright position, and then launched? Or, would it be more feasible to barge them out? Might they be moved to or assembled on "Texas Towers," or would a causeway or simply land-fill be the answer?

Behind the project is our shrinking real estate at launching sites, plus the hazards inherent in launching Saturn-sized missiles (and the coming, nuclear-powered missiles) near other installations. Off-shore launching may be the answer.

Feasibility studies of all types are an AMF specialty. What kind of remotely controlled machinery is required to service nuclear-powered aircraft? What kind of habitation could be built on (or under) the surface of the moon? What sort of machines (manned and unmanned) could survey the moon's surface without, for example, falling into a fissure? What is the best way to assemble a space station? All these are problems AMF engineers are presently investigating.

If your problem is the first of its kind, AMF will not, of course, have met it before. But AMF's long experience in accepting totally unique challenges gives it an advantage enjoyed by few other organizations concerned with ground support, launchability and space environment. To get further information write American Machine & Foundry Company, 261 Madison Avenue, New York 16, N. Y.

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Sr. Metallurgist—Exotic Metals to develop methods of brazing and solid state welding of exotic metals such as Beryllium; growing and fabricating single crystals of aluminum, Niobium and others for use in control devices for space vehicles requiring extreme accuracy; defining smoothness and waviness of surfaces and their measurement; surface treating to gain unique properties.

Sr. Chemist or Chemical Engineer with experience in vacuum evaporation, vapor reduction, and electro-deposition of coatings on metallic and non-metallic base materials or experience with any of the coating methods. Must be capable of developing processes providing uniform adherent deposits of materials having unique properties suitable to advanced gyro and circuitry development.

Sr. Systems Analyst. Must be well grounded in math and have 4 years' experience in analysis of aircraft stability and control. Familiar with both analog and digital computers and capable of applying various types of stability criteria such as phase amplitude plots, root locus, etc. Broad experience in circuit design and closed loop servo-systems.

Transistor Circuit Applications. Experience in audio frequency circuit design or servomechanisms, circuits utilizing transistors, diodes, transformers, magnetic amplifiers, etc. Familiarity with military design requirements desirable.

Electronics Packaging Engineer. 2 years' experience in the basic development of microminiature devices or design of one or more types of electronic components such as semiconductors or resistors. Experience with military hardware requirements desirable.

Senior Electronics Engineer to do analysis of complex servo systems and related circuitry. Must be able to translate analysis into circuitry. Four to six years' experience.

Send your resumé or request for further information to: Mr. Clyde Hansen, Technical Director, Aeronautical Division, 2602-A Ridgway Road, Minneapolis 40, Minn. All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

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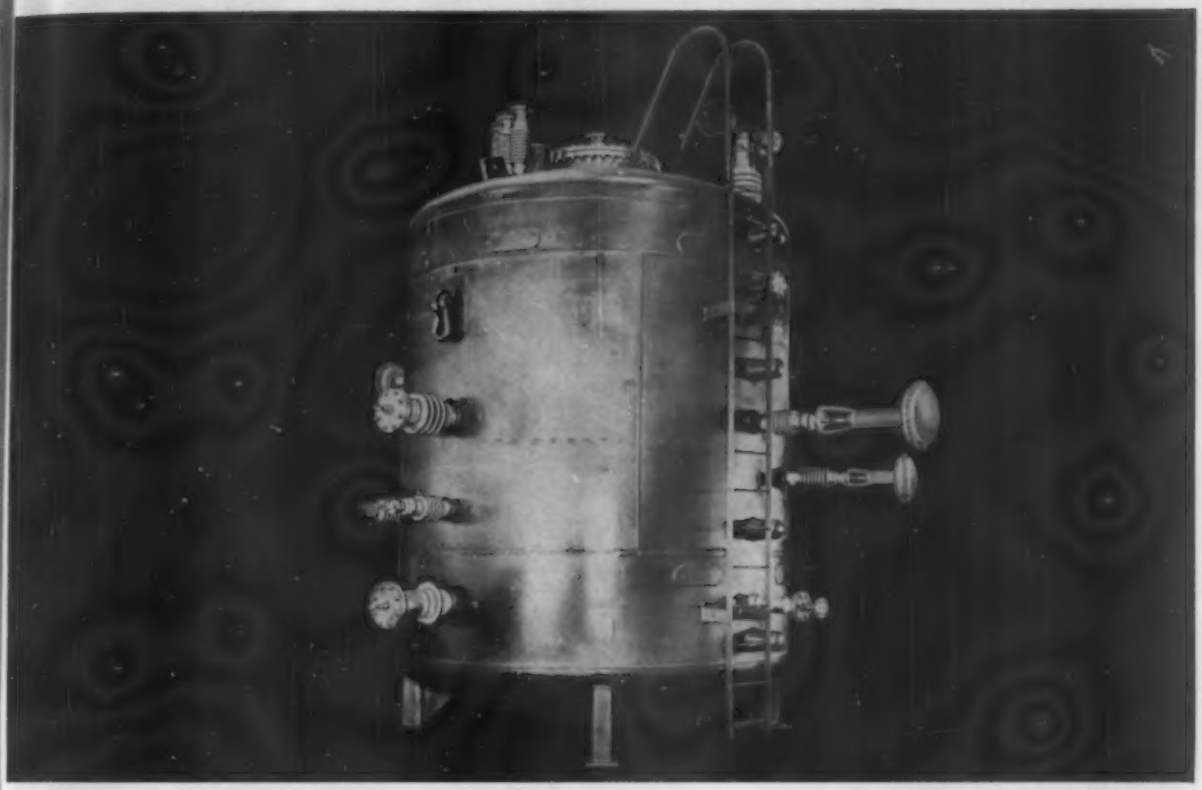

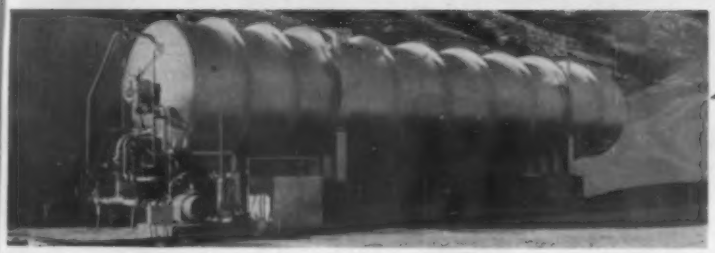

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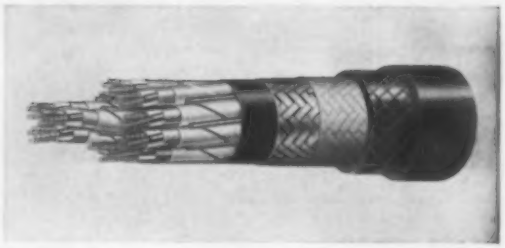

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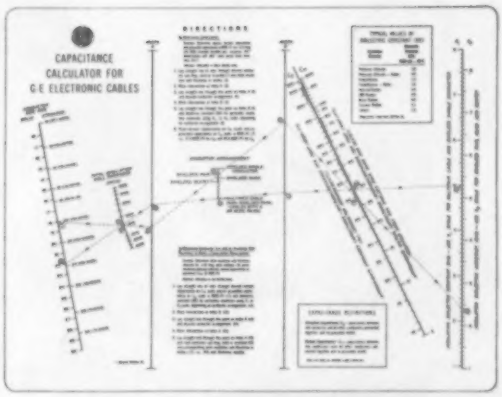

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PROWESS IN SPACE AND AIRCRAFT was demonstrated in Soviet Air Show by helicopter carrying replica of Vostok.

U.S. Stands Pat on Defense Strategy

Administration indicates it is considering only short-term changes in face of Red boost of perhaps $13 billion

by James Baar

THE ADMINISTRATION and a number of leading congressmen are split over a White House decision to stand pat on plans for the nation's strategic forces despite new evidence of growing Soviet power.

Meantime, some close observers of Soviet affairs said the announced Soviet plan to increase military spending $3.5 billion may tell only part of the story. Estimates put the actual figure as high as $13 to $15 billion.

The sharp disagreement between the Administration and Democrats in both the Senate and House became apparent after the Defense Department made clear:

—Its announced "third review" of the nation's military posture as supported by the FY '62 defense budget involves for the most part only the emergency strengthening of conventional forces over the next four to six months.

—The Administration regards the nation's present strategic striking forces and the currently planned build up of them as sufficient. No need for new increases in the FY '62 budget for missiles and bombers is seen.

Soviet Premier Nikita Khrushchev brought on the "third review" by topping his menacing moves over Berlin with the announcement that Russia would pump another 3 billion rubles into its defense budget and halt planned reductions in the size of its military forces.

Khrushchev gave additional punch to his statements the next day by publicly reviewing at least 11 new military aircraft never before displayed. The planes included supersonic jet bombers and missile-packing jet interceptors. The implication clearly was that Soviet interest in manned jet aircraft was not as moribund as Khrushchev had previously indicated.

• **Re-examination**—Defense Secretary Robert McNamara countered the Russian moves after a hurried meeting with President Kennedy and Secretary of State Dean Rusk. McNamara said in a statement issued by the Pentagon July 10:

". . . The fact that the Soviet Union proposes to increase its military spending cannot be overlooked. The simplest precaution calls for still another examination of our defense posture.

"Currently we are strong—if not stronger—than any potential aggressor. But in the face of the inescapable realities that confront us, such as threats to dispossess us of our rightful presence in Berlin, we can do no less than reexamine our needs. This we are doing."

McNamara's statement was widely taken in Congress to mean that the third review of the nation's overall defense posture since the Kennedy Administration assumed office in January was under way. Some congressmen assumed the Pentagon was reviewing early a number of critical questions affecting big missiles and bombers—questions that must be resolved in the coming months.

Among the programs that will be affected by these decisions will be the fixed-base and mobile *Minutemen, Polaris, Nike-Zeus,* the B-70 Mach-3 bomber and the B-52 and B-58 production lines.

Some congressmen talked in terms of boosting the FY '62 defense budget another $1 billion to $2 billion. Acting Chairman A. Willis Robertson (D-Va.)

PRE-AIR SHOW photo in Red Star shows "pursuit" plane with air-to-air rockets preparing to take part in display. At least 11 new aircraft were demonstrated.

of the Senate Defense Appropriations Subcommittee said his committee would delay action on the defense appropriation bills while the Pentagon readied new recommendations.

• **Short-range only**—Then, within 24 hours, Deputy Defense Secretary Roswell Gilpatric disclosed that the Pentagon review was not a new overall study at all. He told a press conference that the review was directed only at measures that can be taken within the next few months to strengthen U.S. conventional forces "before the critical stage is reached in the German situation."

Before he spoke the military services had been ordered to make a two-week study of such matters as the possible calling up of reserve units, the current production rate of conventional ammunition and the cost of increasing aviation fuel stocks.

Either a "misunderstanding" or an overnight switch had occurred.

Gilpatric said the possibility of slowing down the current removal of B-47 bombers from SAC and a possible increase in the number of bombers on airborne alert were being considered. But he said no long-range matters were involved in the review.

"We feel that as of the moment our (strategic) posture is strong," he said. "We do not need to take new measures."

He bypassed explaining how the announced increase in the Soviet defense budget affected Communist military strength over the next few months. He also insisted that the disclosure of new Soviet jet aircraft was not a surprise and was not involved in bringing on the review.

In general, he expressed no alarm at either the Soviet budget increases or the Soviet bombers. On the contrary, he expressed some doubt as to whether the increases were anything more than propaganda.

• **Restive Lawmakers**—Congress showed more alarm.

Three Democratic senators—Clair Engle (Calif.), Howard Cannon (Nev.) and Stuart Symington (Mo.)—called for acceleration of the B-70 R&D program and increased bomber procurement. All urged that the Administration change its plans to freeze the approximately half-billion added to the FY '62 appropriations bill by the House for bombers.

Symington complained that U.S. military strategists have been cancelling fighter programs while the Russians have been developing new models. And he added: "If we do not go forward with the B-70, we will be abandoning the field in which the Russians have demonstrated they have been concentrating for some time."

In both the Senate and House, other congressmen made clear that they were worried by the Soviet disclosures and budget increases. A number felt the Administration was putting off for six months decisions that should be made now.

One of these being stressed particularly is the procurement of long-lead-time parts of *Polaris* submarines beyond the 29 ships already planned by the Administration. Failure to begin work on these parts this fall will result in a month-for-month slippage on every ship beyond the 29th.

Another pending decision being stressed is the initiation of construction of fixed *Minuteman* bases beyond the 12 squadrons now planned and the reinstatement of the mobile *Minuteman* as a currently funded program.

Failure to act on the fixed *Minuteman* this fall will mean the steady loss of the potential gain from the expansion of *Minuteman* production facilities. The mobile *Minuteman* already is slipping on about a month-for-month basis.

• **Invisible buildup**—The full impact of the announced increase in the Soviet defense budget has yet to be determined. However, if the increase is carried out, it is certain that the impact will be considerable.

For the last five years the Russians have officially earmarked between 9 and 10 billion new rubles a year for their Armed Forces—between about $10 and $11 billion according to the official exchange rate. The addition of 3 billion rubles is the first admitted increase.

But, in making U.S.-Soviet budgetary comparisons, many experts believe that the armed services item can be considered to account for only about 25% of the total Soviet military budget. The bulk of the Soviet military budget is scattered in other accounts, either directly or indirectly. Total Soviet military spending is generally estimated at about $40 to $45 billion.

Therefore, the 3-billion ruble increase could well be merely the visible portion of a far larger boost in military spending. The total figure could well run as high as $15 billion.

Among other things, such increases could well mean the Russians are beginning much more rapid deployment of long-range missiles and large-scale production of nuclear-powered submarines.

It was in the face of these possible developments that Gilpatric said the Administration saw no need at this time for the consideration of new overall increases. ⌗

Defense Ad Ban Fought In Senate

THE SENATE Defense Appropriations Subcommittee is considering arguments in favor of dropping a controversial amendment to the House-passed FY '62 defense bill which would bar defense advertising at an allowable contract cost.

The bill is expected to be reported to the Senate in about two weeks. There are indications that, if not eliminated altogether, the amendment will be relaxed to permit defense contractors to charge off advertising for new employes, scarce materials and the disposing of surplus materials.

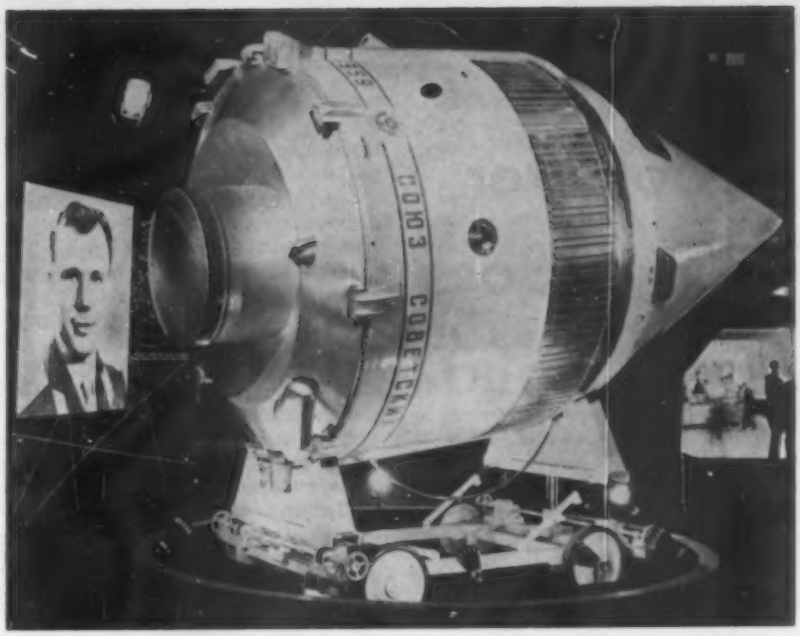
Only one witness, Sen. Howard Cannon (D-Nev.), who had charged in a Senate speech that the Federal Government was paying $500 million a year directly or indirectly in defense advertising costs, appeared in favor of the amendment at a hearing last week. Declaring that trade and technical publications "perform a worthwhile contribution," Cannon said he thought if the amendment were adopted these journals would "continue to exist based on their merit and their editorial excellence rather than on subsidy." Cannon opposed advertising which merely promotes a company's name.

Publishing and advertising witnesses who appeared in opposition said the exchange of new technical information would be impeded, thereby hurting the national defense effort, because defense industry publications would be "hamstrung by dwindling income."

Louis J. Perrottet, vice chairman for legislation of National Business Publications Inc., said DOD estimated the actual amount spent on advertising at $5-10 million. Perrottet, whose organization is comprised of 210 trade, technical, scientific and industrial publications, urged the subcommittee to consider clarification of procurement rules through a separate bill defining the "legitimate scope of advertising."

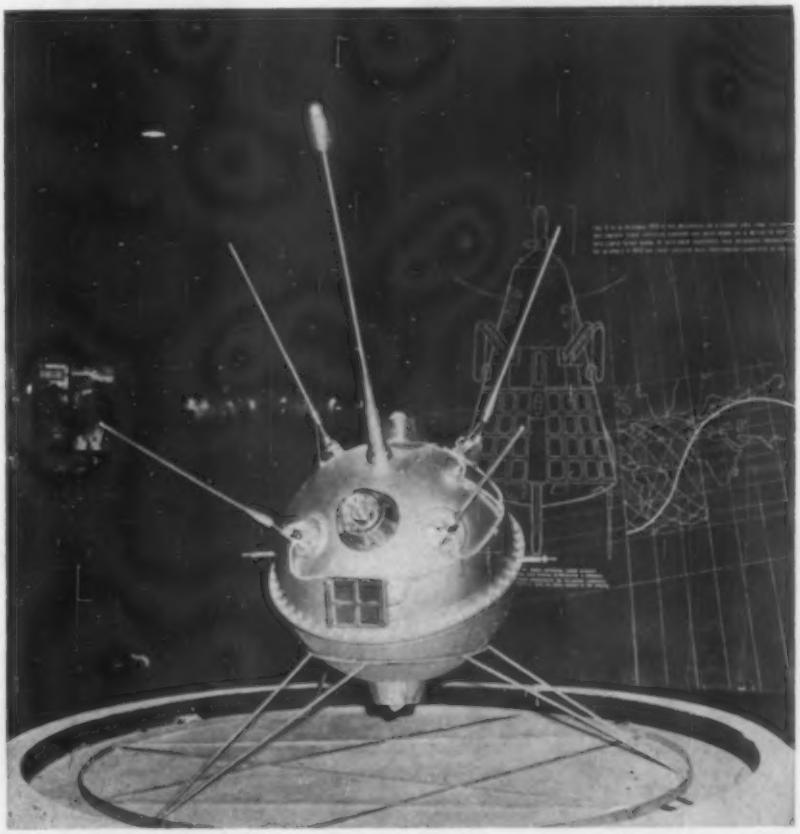
He said there were "popular misconceptions, misinformation and incorrect publicity regarding the nature of advertising for which the government is reimbursing contractors, adding it was a "relatively small portion" of the total cost of any contract.

The Aerospace Industries Association also urged the subcommittee to revise procurement rules affecting advertising rather than take legislative action. AIA promised to "help eliminate inequities or abuses in our field." ⌗



British Get Look at Soviet Spacecraft

ALTHOUGH BILLED as a main attraction of its London Industrial Exhibition, Russia's space research exhibit turned out to be rather superficial and disappointing to those who had hoped to see the latest in Soviet spacecraft. The major interest was a replica of the Mechta lunar vehicle (above) which was unlabelled, leading many visitors to think it was Yuri Gagarin's Vostok. The Mechta payload was shown by itself (below) along with replicas of Sputniks I, II and III. Gagarin himself showed up for the opening of the exhibit and received a hero's welcome from the British. He also ate lunch with the Queen.



NASA Looks for 'Super' Boss For Apollo

Wide range of prospects is surveyed amid disagreement over qualifications; set-up of program itself is clear

by Hal Taylor

Polaris Boss Raborn
. . . the answer was no.

NASA IS PLANNING to create within itself a "super management" organization to run the multibillion-dollar lunar expedition. But the space agency is having difficulty in finding a boss for the job.

MISSILES & ROCKETS has learned that Vice Adm. William F. Raborn,, director of the Navy's *Polaris* program, was offered the top spot more or less informally. He has declined.

There is a possibility, considered remote, that the White House might ask Raborn to change his mind. This would mean leaving the Navy—and a chance to become Chief of Naval Operations. Raborn has seven years to go before retirement.

Administration officials want a man of Raborn's stature to head the *Apollo* program—a man who not only can manage a program of its magnitude, but who will become a super salesman in convincing the American public of the validity of sending men to the moon.

Presently, NASA Administrator James Webb is considering a list of top space scientists and management men in NASA, the military and industry. They include Dr. Wernher von Braun, head of NASA's Marshall Space Flight Center; Robert B. Gilruth, chief of NASA's Space Task Group; James R. Dempsey, president of General Dynamics Astronautics; Gen. Bernard A. Schriever, head of the Air Force's Systems Command; and retired Maj. Gen. John B. Medaris, president of the Lionel Corp.

Sentiment appears to be running against choosing someone from NASA's ranks, Gilruth for example, on grounds he would not be well enough known. As with Raborn, there is a question of availability of several men on Webb's list.

Even when Webb arrives at a choice of the "right type for the job," there will still be conflicts to be resolved before the right type thinks the job is right for him.

• **To be Czar?**—One relates to just how much power he would have. A White House official indicates that Project *Apollo* head should be some sort of a czar who would report only to Mr. Webb. NASA officials take the stand that there is no need for a czar. As one put it, "what we need is a man who can command the loyalty and cooperation of a lot of diverse people." He said that the present NASA view is that the man in charge of the lunar program should be responsible to Webb, Dr. Hugh L. Dryden, Deputy Administrator, and Dr. Robert C. Seamans, Jr., Associate Administrator.

Another question mark is just how high a priority the program will get from the White House. Will Project *Apollo* be able to command the personnel and the materials it needs—or will certain defense requirements come first?

• **Structure Set**—While a final decision on the top manager of the program will not be made for some time, NASA thinking on the type of management structure seems to be pretty well advanced.

Current plans in the agency indicate that the Project *Apollo* setup will include:

—NASA's Space Task Group, presently based at Langley Field, Va., to be responsible for the development of the spacecraft needed to carry three men to the moon and back. In addition, it will direct the research necessary to solve such problems as solar flare radiation, and the mystery surrounding the surface of the moon.

—Marshall Space Flight Center in Huntsville, Ala., to be responsible for the development of the booster needed for lunar exploration. This will include the preparation of specifications for the Air Force's solid-propellant booster which will compete with a NASA-developed liquid booster for the role as the first stage of *Nova*, the lunar vehicle. Once a decision has been made, the center will have to see that the vehicle is ready for the first attempt to orbit the spacecraft which is now scheduled for 1965.

—Towering over both will be a management superstructure responsible for the allocation of funds, priorities, and the job of making sure that all the various segments come together at the right time to insure a successful program.

The task facing the *Apollo* head and the management structure is an immense one.

NASA estimates that getting a man to the moon and back will cost some $20 billion over the next ten years. The space agency has requested and probably will get $1.7 billion for the current fiscal year, including the additional $549 million requested by President Kennedy for the stepped-up space program.

In fiscal 1963, the NASA budget will approach and perhaps even surpass $3 billion.

The cost of the program is only part of the story. Just as awesome is its complexity.

A study prepared by a private group for NASA estimates that the *Apollo* management will have some 1000 major separate tasks to perform, initiate, check, develop and delegate. These tasks will range from a final decision as to the type of booster the *Nova*

vehicle will use to the solution of all the technical problems that a man on the moon may meet, including the question of whether man will be able to expose himself to "weightlessness" for as long as a week.

• **Calling on PERT**—It is expected that the management superstructure will utilize the *Polaris* management concept "PERT"—Program Evaluation and Review Techniques.

PERT involves the use of computers to insure that all segments of the program are proceeding and will be completed on schedule.

NASA officials indicate that there are few alternatives from their present management concept. One possibility would be a non-profit captive space technology corporation similar to Aerospace Corporation, which was set up by the Air Force to perform research and development work.

NASA officials are not yet sure where the *Apollo* management will be located, but said that the chances are good that it will be set up in Washington. There is a possibility, however, that it might hang its hat, along with NASA's Space Task Group at the proposed $60-million Space Research Lab which the agency wants to build. Reports indicate that the lab will be built in Houston, Tex., but other sites have also been mentioned.

• **Key conference**—While many decisions on Project *Apollo* are still to be made, NASA will take a giant step forward in the program this week when it holds a joint industry-government conference on *Apollo*. Some 1000 representatives from 360 space industry firms are expected to attend.

Information supplied to industry representatives attending the conference is classified, but NASA said that its primary purpose will be to acquaint industry with the research the government has already done. Three firms, Martin, Convair and GE, will also present feasibility studies which they have conducted on the program.

According to NASA, the conference agenda will include:

July 18—Presentations on the *Apollo* Space vehicle system, *Apollo* mission profiles, navigation, guidance, and controls, and spacecraft propulsion.

July 19—Sessions on space environment, heating, onboard systems, landing systems and crew participation.

July 20—Description of design and operational aspects of Project *Mercury* pertinent to Project *Apollo*.

NASA expects to present its specifications for the *Apollo* spacecraft at a bidders conference in late July or early August. The prime contract will be awarded early in 1962. ¤

'Liberty Bell' Mercury Shot Due

THE UNITED STATES is scheduled to attempt its second manned space flight on July 18, using an advanced version of the Mercury Redstone spacecraft nicknamed the "Liberty Bell."

The new shot, if successful, will spark a sharp increase in Project Mercury activity. Slated to follow sometime next month is the third manned flight. Coming up in September are two scheduled attempts to orbit a Mercury spacecraft—one unmanned and the other carrying a monkey.

While NASA has said nothing officially, America's second astronaut is expected to be Virgil L. Grissom. The backup pilot would then be John H. Glenn, Jr.

The second flight—to be made, like the first, from Cape Canaveral—will almost duplicate Project Mercury's first manned journey into space by Alan Shepard on May 5.

The "Liberty Bell" will be quite similar to the earlier Freedom 7 craft. It, too, will weigh about two tons at liftoff, measure six ft. across its blunt bottom, and stand nine ft. high. It will also be fitted out with a 16-ft. escape tower, its titanium pressure cabin housed in a "shingled" skin of temperature-resistant alloy.

However, there will also be changes from the first flight and first spacecraft.

A new launch angle will be used to create a flight trajectory with approximately one mile higher altitude and three miles shorter range than were programed for the Shepard flight. The astronaut will also have fewer tasks to perform, and more time to look out of a new, enlarged "pilot observation" window 19 inches high, 11 inches across its base and 7½ inches across its top.

Air Defense Gets Space Spotting System

A SYSTEM to provide round-the-clock electronic cataloguing of all man-made objects in space has been installed at the headquarters of the North American Defense Command in Colorado Springs, Colo.

The Space Detection and Tracking System — nicknamed SPADATS — will provide the NORAD commander with a reliable, up-to-date means of evaluating the threat posed by an unidentified object.

• **Computer heart**—As part of SPADATS, Air Force- and Navy-operated sensors feed information into an electronic data processing system located in the NORAD Combat Operations Center. The computer—a Philco general-purpose, asynchronous machine—analyzes the inputs, performs orbital calculations and comparisons and catalogues the data. It then transfers the flight prediction back to the sensor stations so that they can anticipate the next appearance of the space object in their sector.

The computer also determines any changes in the flight of satellites or space vehicles, including the decay orbits of vehicles.

• **Realignment**—As a result of a realignment of the military space detection and tracking functions in November, 1960, NORAD assumed control of the "space track function."

This includes SPASUR—Space Surveillance Detection Net—which was developed by the Navy to discover "dark" or non-radiating satellites functioning across the southern U.S., and SPACETRACK—National Space Surveillance Control Center—which previously had received, analyzed and catalogued the orbital data received from SPASUR and other sources.

• **System functioning**—Using radar, radiometric and optometric techniques to obtain a "fix" on a man-made object in space, tracking stations throughout the world detect and obtain orbital parameters on a satellite or space vehicle. This information is transmitted by teletype to the SPADATS center at NORAD headquarters.

The high-speed computer accepts and digests all these inputs and, utilizing its pre-programed memory, sorts, categorizes and places into inventory the data concerning a particular vehicle. Upon command, or at pre-determined intervals, the computer prints out a summary of the information gathered on orbiting vehicles. The system can also be used to predict the location of a particular space vehicle at some future time.

Finally, the computer advises the sensors of anticipated locations of new orbital passes and digests other tracking data against which new readings by sensor stations can be matched.

SPADATS is manned by technicians from the 1st Aerospace Squadron, a component unit of the USAF Air Defense Command. ¤

UAR shops for rockets . . .

A Missile Race in the Middle East?

LEFT: *Near launching point of Shavit II are (left to right) Shimon Peres, Israeli Deputy Minister of Defense; Prime Minister and Minister of Defense David Ben-Gurion; Meir Mardor, Director of Development, Ministry of Defense; and Maj. Gen. Zvi Zur, Chief of Staff of Israel Defense forces.* **RIGHT:** *The rocket in flight. Photos from Strategic.*

(Special to MISSILES AND ROCKETS)

TEL AVIV—Israel's Defense Ministry is believed preparing to launch two more solid-fueled rockets this month in a developmental series apparently aimed at producing a tactical missile.

One of the shots is expected to be a duplicate of the *Shavit II* (Comet) fired to a height of about 50 miles July 5 from a secret launching site on the shores of the Mediterranean. The other reportedly will be a larger rocket. *Shavit II* had either two or three stages.

Only superficially disguised as a "weather research rocket" (it released a charge of sodium at apogee but did not carry other instrumentation), the *Shavit* firing set off a tremor in the delicate Middle East power balance.

The United Arab Republic, it was disclosed in Washington, is negotiating with Zimney Corp., Monrovia, Calif., for the purchase of sounding rockets it says it wants to use to conduct its own meteorological research program—an explanation quickly denounced in Congress as an attempt to obtain information to build a military rocket.

In a telegram to Secretary of State Rusk, Rep. William Fitts Ryan (D-N.Y.) asked that an export license granted to Zimney be suspended. Claiming the UAR would use the rockets to analyze their components and fuel, Ryan said:

"I am informed that the UAR does not have a proper scientific program for the use of these rockets. In my opinion rockets will be used in connection with the July 23 celebration of (UAR President Gamal Abdel) Nasser's rise to power for propaagnda purposes." However, it was believed the rockets were shipped July 3.

• **Defense problems**—Israel Deputy Defense Minister Shimon Peres admitted candidly that the rocket program being conducted in great secrecy by Israeli scientists is being given priority because of "grave defense problems."

Manufactured by the government Military Industries, which produces propellant for air-to-air rockets, bazookas and explosives for ammunition, the *Shavit II* weighed more than 550 lbs. Well informed sources said it will have a range of about 70 miles—about the same as a U.S. *Sergeant* tactical missile. Speed is put at 4921 ft./sec. Cost—exclusive of R&D—about $25,000.

Development of the rocket is under the Research and Scientific Planning Department of the Defense Ministry's Authority for Development of Arms and Fighting Equipment. Chief of research is Dr. Ernst Bergman, also a director of the Israel Atomic Energy Committee.

Disclosure of Israel's construction of an atomic reactor several months ago has given rise to speculation that it might try to arm a rocket with a nuclear warhead as well as produce other nuclear armaments.

The formula for the propellant is said to have been devised by Israeli scientists, although names of members of the rocket team are being withheld for "security reasons." Neither was the exact length of the development program revealed. One source says "it would be correct to say that the last 12 months had been spent on most parts of the project"—a rather short time without outside assistance.

It is understood, however, that some of the work was done at the Technical Institute in Haifa, whose Aeronautical Department is conducting some research for the U.S. Air Force. ■

LIONEL: Muscles for Missiles

Forming and machining the ultra-tough materials needed in missile manufacture requires muscle... well-developed power and brawn... to precisely bend and shape and expand and finish parts which ultimately become stronger than the machines that produced them.—■—In this respect we feel that the Lionel organization is especially capable. For materials which resist conventional fabricating methods, we've built our own muscles ... our own machines and equipment, our own tools, devices, and techniques... all capable of processing obstinate alloys to fine tolerances at high speeds on a routine production basis.—■—Lionel-designed machines such as the "IMPRES" (Internal Mandrel Pressure Roll Extrusion Shaper) provide high-speed hydroforming of nose cones with superior dimensional accuracy.—■—In its entirety, The Lionel Corporation presents a vast capabilities complex, each division highly experienced in the design, development, and construction of advanced high quality hardware. Our engineers, physicists and chemists, equipped with modern, efficient laboratory and production facilities, afford a logical and worthy source for the dependable fulfillment of contractual commitments—from components through systems.

We welcome your further inquiry... and suggest that you request a copy of our new capabilities brochure, "LIONEL: A New Force."

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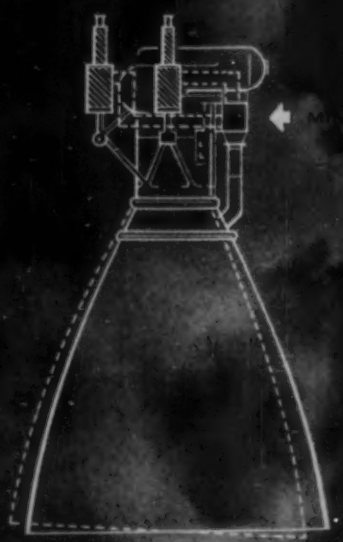

POWER PACKAGE

This miniaturized unit provides a positive power source for 360° directional control of satellite rocket...yet a dozen precision assemblies fit into package weighing only 8¼ pounds and less than 8 inches long...gear type motor delivers 2.4 hp at 8.7 gpm and 840 psi with UDMH fluid...piston pump flow ranges to 1 gpm at pressures to 4000 psi, speeds greater than 11,000 rpm. Each component assembly can be used individually or in the power package produced by Lear-Romec for your hydraulic application...write to Lear-Romec for details.

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FIFTH ANNUAL

Missiles and Rockets

WORLD MISSILE/SPACE ENCYCLOPEDIA

1961

Compiled and Edited by the Staff of Missiles and Rockets

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STRATEGIC MISSILES

Base-building delays slowed deployment of big U.S. strategic missiles in 1961. But this was offset somewhat by an increase in Polaris submarines.

Less than 50 Atlases were expected to be operational by the end of 1961; the first Titan squadron was slipping into 1962. To the three Polaris subs on station

ATLAS (Air Force)

MILITARY DESIGNATION: SM-65

TYPE: ICBM surface-to-surface (fixed base)

STATUS: Operational

PRIME CONTRACTOR: Convair-Astronautics Division, General Dynamics Corp.

PERFORMANCE: *Range*—more than 8000 n. miles. *Speed*—about 18,000 mph. *Apogee*—more than 600 n. miles.

FRAME: *System contractor*—Convair. *Length*—82.5 ft. *Diameter*—10 ft. *Launch weight*—266,000 lbs. *Material (major)*—stainless steel.

GUIDANCE: *System contractor:* GE/Burroughs; Bosch Arma. *Type*—1st four squadrons radio-inertial, last nine all inertial.

BOOSTER: *System contractor*—Rocketdyne. *Propellant*—LOX and RP-1. *Thrust*—165,000 lbs. each of two boosters.

SUSTAINER: *System contractor*—Rocketdyne. *Propellant*—LOX and kerosene. *Thrust*—60,000 lbs.

RE-ENTRY VEHICLE: *System contractor*—General Electric/Avco. *Warhead type*—nuclear.

G.S.E.: *Launcher*—Convair. *Fueling*—Arthur D. Little Co. *Handling and service*—Goodyear Aircraft. *Transport vehicles*—Goodyear Aircraft.

REMARKS: Atlases in silos beginning with squadron 8 will have reduced reaction time.

DEPLOYMENT

SQUADRONS PLANNED: 13

BASES PLANNED: 10

SQUADRON STRENGTH: 6 to 12 missiles

INITIALLY OPERATIONAL: Sept. 9, 1959 at Vandenberg AFB, Calif.

TOTAL NUMBER OF MISSILES ON LAUNCHERS: 132 (Missiles at Vandenberg also used for training)

Squadron Locations

VANDENBERG AFB, LOMPOC, CALIF. One squadron—9 missiles, 6 soft, 3 hard, non-dispersed.

WARREN AFB, CHEYENNE, WYO. Three squadrons—(1) 6 missiles, soft, non-dispersed; (2) 9 missiles, soft, semi-dispersed; (3) 9 missiles, semi-hard, dispersed.

OFFUTT AFB, OMAHA, NEB. One squadron—9 missiles, semi-dispersed, soft.

FAIRCHILD AFB, SPOKANE, WASH. One squadron—9 missiles, dispersed, semi-hard.

FORBES AFB, TOPEKA, KANS. One squadron—9 missiles, dispersed, semi-hard.

SCHILLING AFB, SALINA, KANS. One squadron—12 missiles, dispersed, hard.

LINCOLN AFB, LINCOLN, NEB. One squadron—12 missiles, dispersed, hard.

ALTUS AFB, ALTUS, OKLA. One squadron—12 missiles, dispersed, hard.

DYESS AFB, ABILENE, KANS. One squadron—12 missiles, dispersed, hard.

WALKER AFB, ROSWELL, N.M. One squadron—12 missiles, dispersed, hard.

PLATTSBURGH AFB, PLATTSBURGH, N.Y. One squadron—12 missiles, dispersed, hard.

Operational model
Atlas leaves pad at Canaveral—Several squadrons are on combat status

at mid-year, however, the Navy planned to add two and possibly three for a total of 80-96 Polarises operational by 1962.

The new Kennedy Administration decided against a major increase in the ICBM program—putting the total due to be on launchers by 1965 at about 1300. Polaris is being accelerated, but no provision was made beyond the 29th boat (the Navy wants a fleet of 45); the mobile Minuteman launcher was shelved.

More Minuteman production facilities were authorized, but there was no sign that the number in silo launchers would be increased beyond the planned 600.

MINUTEMAN (Air Force)

MILITARY DESIGNATION: SM-80

TYPE: ICBM surface-to-surface (fixed base and mobile)

STATUS: R&D

MAJOR CONTRACTOR: Boeing Co.

PERFORMANCE: *Range*—5500 n. miles. *Speed*—more than 15,000 mph. *Apogee*—about 600 miles.

FRAME: *System contractor*—Boeing. *Length*—56 ft. *Diameter*—about 6 ft. *Launch weight*—64,300 lbs. *Material (major)*—steel (first two stages), titanium or plastic (third stage).

GUIDANCE: *System contractor*—Autonetics. *Type*—all inertial.

BOOSTER: *System contractor*—Thiokol. *Propellant*—solid. *Thrust*—about 160,000 lbs.

SECOND STAGE: *System contractor*—Aerojet-General. *Propellant*—solid.

THIRD STAGE: *System contractor*—Hercules Powder. *Propellant*—solid.

RE-ENTRY VEHICLE: *System contractor*—Avco. *Warhead type*—nuclear.

G.S.E.: *Launcher*—Boeing. *Handling and service*—Boeing. *Transport vehicles*—Boeing.

REMARKS: Mobile program deferred 18-24 months.

DEPLOYMENT

SQUADRONS PLANNED: 12 (fixed site)

BASES PLANNED: 4

SQUADRON STRENGTH: 50 missiles

INITIALLY OPERATIONAL: Mid-1962

TOTAL NUMBER OF MISSILES ON LAUNCHERS: 600

Squadron Locations

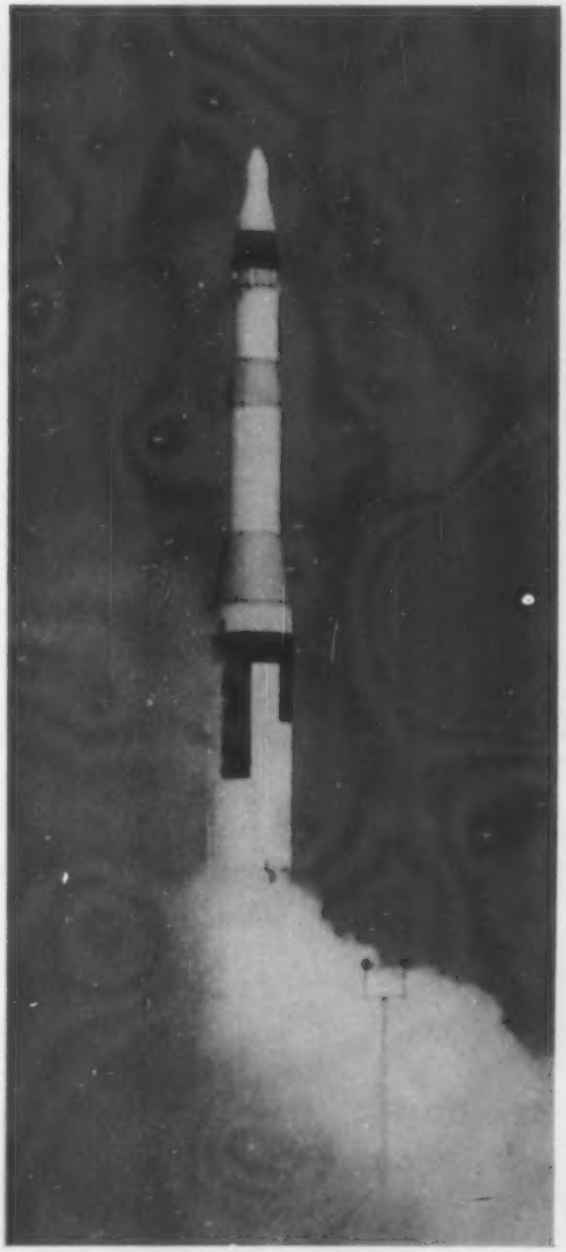
MALMSTROM AFB, MONT. Three squadrons in dispersed, hardened silos, in-silo launch.

ELLSWORTH AFB, S.D. Three squadrons in dispersed, hardened silos, in-silo launch.

HILL AFB, UTAH. Railhead for first train-based mobile squadrons when developed.

MINOT AFB, N.D. Three squadrons in dispersed hardened silos, in-silo launch.

WHITEMAN AFB, MO. Three squadrons in dispersed hardened silos, in-silo launch.



Successful first flight of Minuteman in early 1961. Solid-fueled ICBM is to be operational in 1962

LOADING Polaris subs at Charleston, S.C., Depot

1500-mile Polaris A-2

POLARIS (Navy)

MILITARY DESIGNATION: FBM
TYPE: Submarine or surface ship-launched IRBM surface-to-surface (mobile)
STATUS: A-1 operation; A-2 and A-3 R&D
PRIME CONTRACTOR: Lockheed Missiles and Space Division, Lockheed Aircraft Corp.
PERFORMANCE: *Range*—1200 n. miles (A-1), 1500 n. miles (A-2), 2500 n. miles (A-3). *Speed*—about 8000 mph. *Apogee*—about 400 miles.
FRAME: *System contractor*—Lockheed. *Length*—28 ft. (A-1); 30.5 ft. (A-2 and A-3). *Diameter*—4.5 ft. *Launch weight*—28,000 lbs. (A-1), about 30,000 (A-2) about 30,000, (A-3) more than 30,000. *Material (major)*—steel
GUIDANCE: *System contractor*—General Electric/MIT. *Type*—all inertial.
BOOSTER: *System contractor*—Aerojet-General. *Propellant*—solid *Thrust*—about 100,000 lbs.
SUSTAINER: *System contractor*—Aerojet-General. *Propellant*—solid.
FIRE CONTROL: *System contractor*—General Electric.
NAVIGATION: *System contractor*—Sperry-Gyroscope / Autonetics. *Type*—inertial (SINS).
RE-ENTRY VEHICLE: *System contractor*—Lockheed. *Warhead type*—nuclear.
G.S.E.: *Launcher*—Westinghouse. *Handling and service*—Westinghouse/Lockheed. *Transport vehicles*—Lockheed.
REMARKS: Advanced 1500 n. mile and 2500 n. mile models under development. NATO nations may purchase for deployment as land-based NATO IRBM.

DEPLOYMENT

MISSILE-LAUNCHING NUCLEAR-POWERED SUBMARINES PLANNED BY NAVY: about 45.
SUBMARINES AUTHORIZED PART OR WHOLE: 29.
MISSILES PER SUBMARINE: 16
INITIALLY OPERATIONAL: 1960.
TOTAL NUMBER OF MISSILES: (authorized): 464

Polaris Submarines

GEORGE WASHINGTON 380 ft. 5600 tons commissioned 1960 Electric Boat
PATRICK HENRY 380 ft. 5600 tons commissioned 1960 Electric Boat
THEODORE ROOSEVELT 380 ft. 5600 tons commissioned 1960 Mare Island
ROBERT E. LEE 380 ft. 5600 tons commissioned 1960 Newport News Ship
ABRAHAM LINCOLN 380 ft. 5600 tons commissioned 1960 Portsmouth Naval
ETHAN ALLEN 410 ft. 6900 tons commissioned 1961 Electric Boat
SAM HOUSTON 410 ft. 6900 tons launching 1961 Newport News Ship
THOMAS A. EDISON 410 ft. 6900 tons launching 1961 Electric Boat
JOHN MARSHALL 410 ft. 6900 tons launching 1961 Newport News Ship
LAFAYETTE 425 ft. 7000 tons launching 1962 Electric Boat
ALEXANDER HAMILTON 425 ft. 7000 tons launching 1962 Electric Boat
THOMAS JEFFERSON 410 ft. 6900 tons launching 1962 Newport News
ANDREW JACKSON 425 ft. 7000 tons launching 1962 Mare Island
(Sixteen more authorized or requested by Administration)

TITAN (Air Force)

MILITARY DESIGNATION: SM-68

TYPE: ICBM surface - to - surface (fixed base).

STATUS: Titan I nearly operational, Titan II R&D

PRIME CONTRACTOR: Martin Co.

PERFORMANCE: *Range*—more than 5500 n. miles. *Speed*—17,000 mph. *Ceiling*—more than 600 miles.

FRAME: *System contractor*—Martin. *Length*—98 ft. (Titan I), more than 100 ft. (Titan II). *Diameter (max.)*—10 ft. *Launch weight*—220,000 lbs. *Material (major)*—2014K aluminum.

GUIDANCE: *System contractor*—Bell Telephone Laboratories/Remington Rand UNIVAC (Titan I), A.C. Spark Plug (Titan II). *Type*—radio inertial first six squadrons; later squadrons all inertial.

BOOSTER: *System contractor*—Aerojet General. *Propellant*—LOX and RP-1 (Titan I); UDM4 and hydrazine/nitrogen tetroxide Titan II). *Thrust* — 300,000 lbs. (Titan I); nearly 500,000 lbs. (Titan II).

SUSTAINER: *System contractor*—Aerojet General. *Propellant*—LOX and RP-1. *Thrust* — 80,000 lbs. (Titan I); 100,000-120,000 lbs. (Titan II).

RE-ENTRY VEHICLE: *System contractor*—Avco (Titan I); G.E. (Titan II). *Warhead type*—nuclear.

G.S.E.: *Launcher*—Martin. *Fueling*—Air Products/Cambridge Corp. *Handling and service* — Martin. *Transport vehicles*—North American. *Elevator*—AMF.

REMARKS: Longer range Titan II will have a storable propellant and will be launched from its underground silo. Titan II will be deployed with Squadron 7.

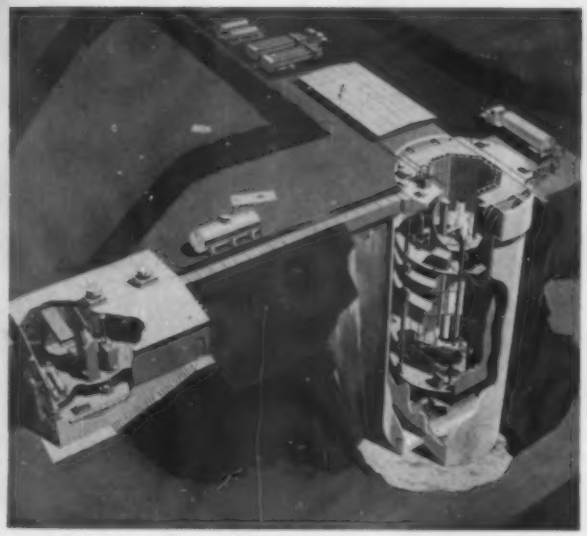


Diagram of Titan test facility

DEPLOYMENT

SQUADRONS PLANNED: 12

BASES PLANNED: 8

SQUADRON STRENGTH: 9 missiles

INITIALLY OPERATIONAL: 1961 (Titan I); 1963 (Titan II)

TOTAL NUMBER OF MISSILES ON LAUNCHERS: 108

Squadron Locations

LOWRY AFB, DENVER, COLO. Two squadrons — semi-dispersed, hard, elevated to surface for launching.

ELLSWORTH AFB, RAPID CITY, S.D. One squadron — semi-dispersed, hard, elevated to surface for launching.

MOUNTAIN HOME AFB, MOUNTAIN HOME, IDAHO. One squadron — semi-dispersed, hard, elevated to surface for launching.

LARSON AFB, MOSES LAKE, WASH. One squadron—semi-dispersed, hard, elevated to surface for launching.

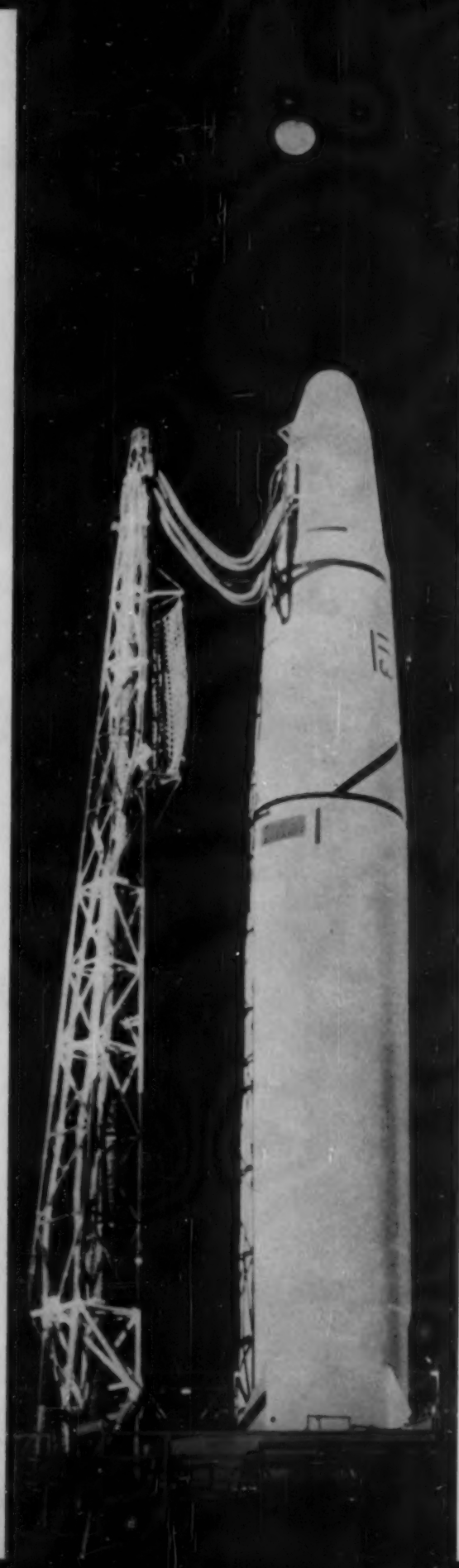
BEALE AFB, MARYSVILLE, CALIF. One squadron — semi-dispersed, hard, elevated to surface for launching.

DAVIS-MONTHAN AFB, TUCSON, ARIZ. Two Titan II squadrons—dispersed, hard, in-silo launched.

McCONNELL AFB, WICHITA, KANS. Two Titan II squadrons—dispersed, hard, in-silo launched.

LITTLE ROCK AFB, LITTLE ROCK, ARK. Two Titan II squadrons—dispersed, hard, in-silo launched.

Nearly operational Titan takes off



THOR (Air Force)

MILITARY DESIGNATION: SM-75

TYPE: IRBM surface-to-surface

STATUS: Operational

PRIME CONTRACTOR: Douglas Aircraft Co., Inc.

PERFORMANCE: *Range*—1500 n. miles. *Speed*—10,000 mph. *Apogee*—about 400 miles.

DEPLOYMENT: *Location*—Great Britain (military); Vandenberg AFB and Cape Canaveral (R&D and training). Initially operational in England—1959. *Total squadrons* — four. *Total bases* — four with 20 sites. *Squadron strength* —15 missiles. *Total missiles deployed*—60.

FRAME: *System contractor*—Douglas. *Length*—65 ft. *Diameter*—8. *Launch weight*—110,000 lbs. *Material (major)*—aluminum.

GUIDANCE: *System contractor*—A.C. Spark Plug. *Type*—all inertial.

BOOSTER: *System contractor*—Rocketdyne. *Propellant*—LOX and JP4. *Thrust*—150,000 lbs.

RE-ENTRY VEHICLE: *System contractor*—General Electric. *Warhead type*—nuclear.

G.S.E.: *Launcher*—Food Machinery. *Fueling*—Daco. *Transport vehicles*—Fruehauf.

REGULUS I

REGULUS I (Navy)

MILITARY DESIGNATION: SSM-N-8

TYPE: Air-breathing surface-to-surface (seaborne)

STATUS: Operational

PRIME CONTRACTOR: Chance Vought Corp.

PERFORMANCE: *Range*—500 n. miles. *Speed*—about 600 mph. *Ceiling*—about 40,000 ft.

DEPLOYMENT: *Location*—aboard five submarines (Growler, Barbero, Grayback, Tunny and nuclear-powered Halibut) and two cruisers (Los Angeles and Helena). *Initially operational*—1954.

FRAME: *System contractor*—Chance Vought. *Length*—34 ft. *Diameter*—4.5 ft. Wingspan—21 ft. *Launch weight*—14,000 lbs. *Material (major)*—aluminum.

GUIDANCE: *System contractor*—Sperry. *Type*—radio command or inertial.

BOOSTER: *System contractor*—Aerojet. *Propellant*—solid. *Number*—two. *Thrust*—33,000 lbs. each.

SUSTAINER: *System contractor*—Allison. *Engine*—J33-18 turbo-jet. *Thrust*—4600 lbs.

PAYLOAD: *Warhead type*—nuclear.

G.S.E.: *Launcher*—Fruehauf. *Fueling*—Chance Vought. *Handling and service*—Chance Vought. *Transport vehicles*—Fruehauf.

REMARKS: Last of more than 500 Regulus I's were delivered in 1958. Production terminated. Warhead considered large.

THOR

JUPITER (Air Force-Army)

MILITARY DESIGNATION: SM-78

TYPE: IRBM surface-to-surface (fixed base or mobile)

STATUS: Operational

PRIME CONTRACTOR: Chrysler Corp.

PERFORMANCE: *Range*—1500 n. miles. *Speed*—10,000 mph. *Apogee*—380 miles.

DEPLOYMENT: *Location*—Italy and Turkey. Initially operational in Italy—1961. *Total squadrons planned*—two in Italy; one in Turkey. *Total fixed bases*—three. *Squadron strength*—15 missiles. *Total missiles*—45.

FRAME: *System contractor*—Chrysler. *Length* — 58 ft. *Diameter* — 8.75 ft. *Launch weight*—105,000 lbs. *Material (major)*—aluminum.

GUIDANCE: *System contractor*—Ford Instrument. *Type*—all inertial.

BOOSTER: *System contractor*—North American Aviation. *Propellant*—LOX and kerosene. *Thrust*—150,000 lbs.

RE-ENTRY VEHICLE: *System contractor*—Goodyear/CTL. *Warhead type*—nuclear.

G.S.E.: *Launcher*—Chrysler. *Fueling*—Chrysler. *Handling and service*—Chrysler. *Transport vehicles*—Chrysler.

REMARKS: Jupiter was developed by the Army Ballistic Missile Agency and turned over to the Air Force for operational deployment.

REGULUS II (Navy)

MILITARY DESIGNATION: SM-N-9A

TYPE: Air-breathing surface-to-surface (seaborne)

STATUS: Operational as KD2A-1 target drone.

PRIME CONTRACTOR: Chance Vought Corp.

PERFORMANCE: *Range* — more than 800 n. miles. *Speed*—more than Mach 2. *Ceiling*—more than 65,000 ft.

DEPLOYMENT: *Location*—PMR, Point Mugu, Calif., and Eglin Test Range, Fla. *Initially operational*: March, 1959.

FRAME: *System contractor*—Chance Vought. *Length*—59.5 ft. *Diameter*: 50 in. *Wingspan*—20 ft. *Launch weight*—up to 30,000 lbs. *Material (major)*—aluminum.

GUIDANCE: *System contractor*—Bell. *Type*—radio command or inertial.

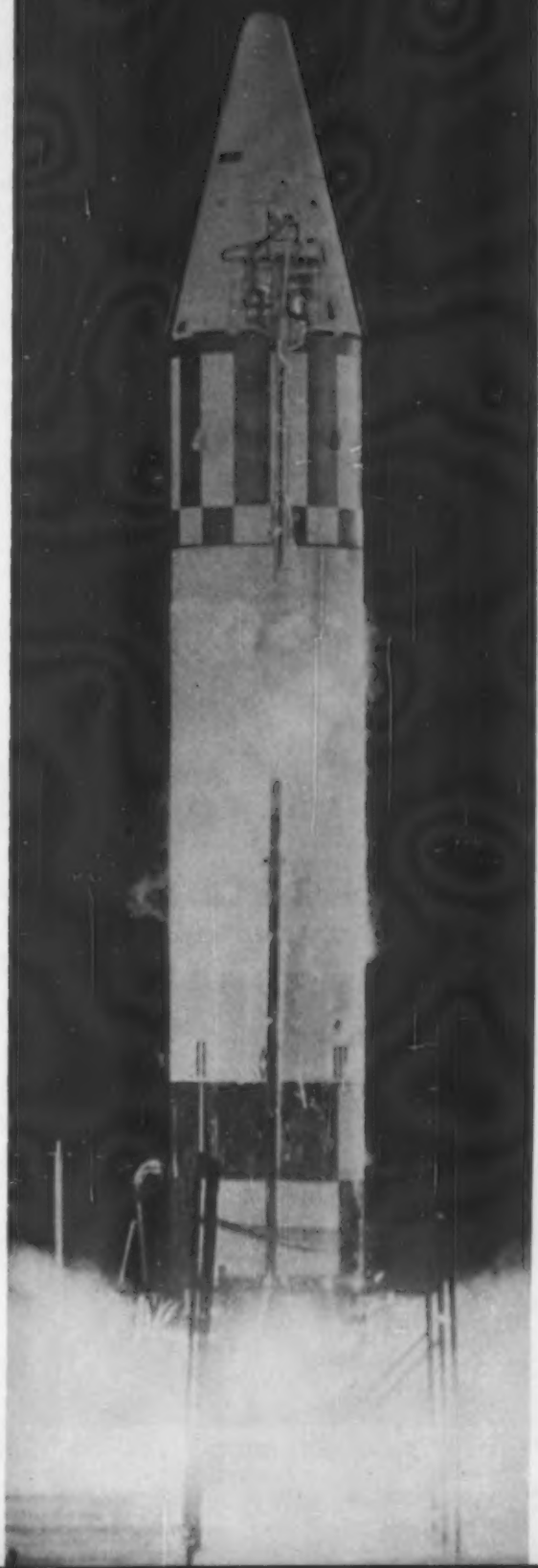
BOOSTER: *System contractor*—Aerojet and Rocketdyne. *Propellant*—solid. *Thrust*—115,000 and 130,000 lbs.

SUSTAINER: *System contractor*—General Electric. *Engine*—J-79-3 turbo-jet. *Thrust*—more than 10,000 lbs.

PAYLOAD: *Warhead type for military version*—nuclear.

G.S.E.: *Launcher*—Fruehauf. *Fueling*—Chance Vought. *Handling and service*—Chance Vought. *Transport vehicles*—Fruehauf.

REMARKS: The Navy cancelled the Regulus II weapon system in December, 1958 for budgetary reasons on grounds that the missile had become obsolescent.



JUPITER

HOUND DOG

HOUND DOG (Air Force)

MILITARY DESIGNATION: GAM-77

TYPE: Air-breathing air-to-surface

STATUS: Operational

PRIME CONTRACTOR: North American Aviation, Inc.

PERFORMANCE: *Range* — more than 500 n. miles. *Speed*—about Mach 2. *Apogee*—air-breather.

DEPLOYMENT: *Location*—SAC B-52 bases in U.S. *Initially operational*—1960. *Total deployed missiles*—expected to exceed 400.

FRAME: *System contractor*—North American. *Length*—42.5 ft. *Diameter*—28 in. *Wing span*—12 ft. *Launch weight*—about 10,000 lbs.

GUIDANCE: *System contractor*—Autonetics. *Type*—all inertial.

POWERPLANT: *System contractor*—Pratt & Whitney. *Engine*—J-52 turbo-jet. *Thrust*—7500 lbs.

RE-ENTRY VEHICLE: *Type warhead*—nuclear.

REMARKS: Hound Dog was developed as an interim weapon for use while the Air Force is developing the far superior Skybolt.

QUAIL

QUAIL (Air Force)

MILITARY DESIGNATION: GAM-72

TYPE: Air-launched missile ECM decoy

STATUS: Operational

PRIME CONTRACTOR: McDonnell Aircraft Corp.

PERFORMANCE: *Range*—more than 200 n. miles. *Speed*—near sonic. *Ceiling*—more than 50,000 ft.

DEPLOYMENT: *Location*—SAC air bases. *Initially operational*—1960

FRAME: *System contractor*—McDonnell. *Length*—12.9 ft. *Wingspan*—5.4 ft. *Launch weight*—about 1200 lbs. *Material*—aluminum and reinforced plastic.

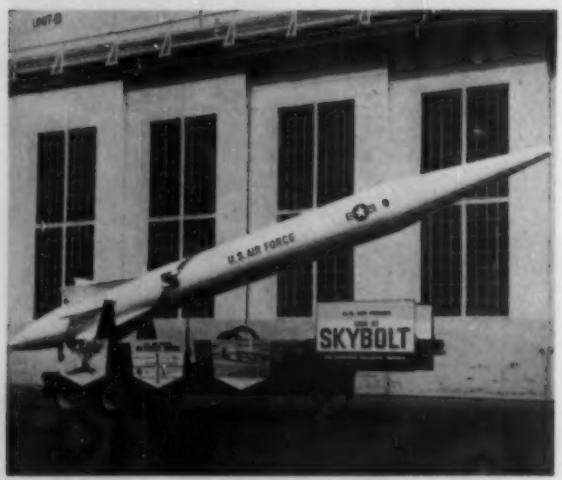
GUIDANCE: *System contractor*—Summers Gyro. *Type*—gyro autopilot.

POWERPLANT: *System contractor*—General Electric. *Engine*—J85-7 turbo-jet. *Thrust*—2450 lbs.

PAYLOAD: *System contractor*—Ramo-Wooldridge. *Type* — electronic countermeasures simulation subsystems.

G.S.E.: *System contractor*—Bell Aircraft.

REMARKS: Quail is designed to serve a dual role as a decoy for a strategic bomber and as a vehicle to carry ECM equipment.



SKYBOLT

SLAM (Air Force)

TYPE: Intercontinental nuclear-powered missile

STATUS: Study

PRIME CONTRACTOR: No contractor announced

PERFORMANCE: *Range*—global. *Speed*—supersonic. *Ceiling*—low altitude.

SUSTAINER: *System contractor*—R&D being conducted by the Atomic Energy Commission, N.A.A. International and Marquardt (Project Pluto). *Engine*—nuclear-powered ramjet.

PAYLOAD: *Warhead type*—nuclear.

REMARKS: Convair, North American and Chance Vought are principal competitors in studies submitted to the Air Force.

SKYBOLT (Air Force)

MILITARY DESIGNATION: GAM-87A

TYPE: air-to-surface ballistic missile (ALBM)

STATUS: R&D

PRIME CONTRACTOR: Douglas Aircraft Co.

PERFORMANCE: *Range*—1000 n. miles. *Speed*—hypersonic.

DEPLOYMENT: *Location*—SAC air bases. Also RAF bases in England. (Skybolts may be launched from variety of aircraft besides bombers—particularly tankers and transports.) *Initially operational*—about 1964. B-52's to carry 4 missiles; Vulcans, 2.

FRAME: *System contractor*—Douglas.

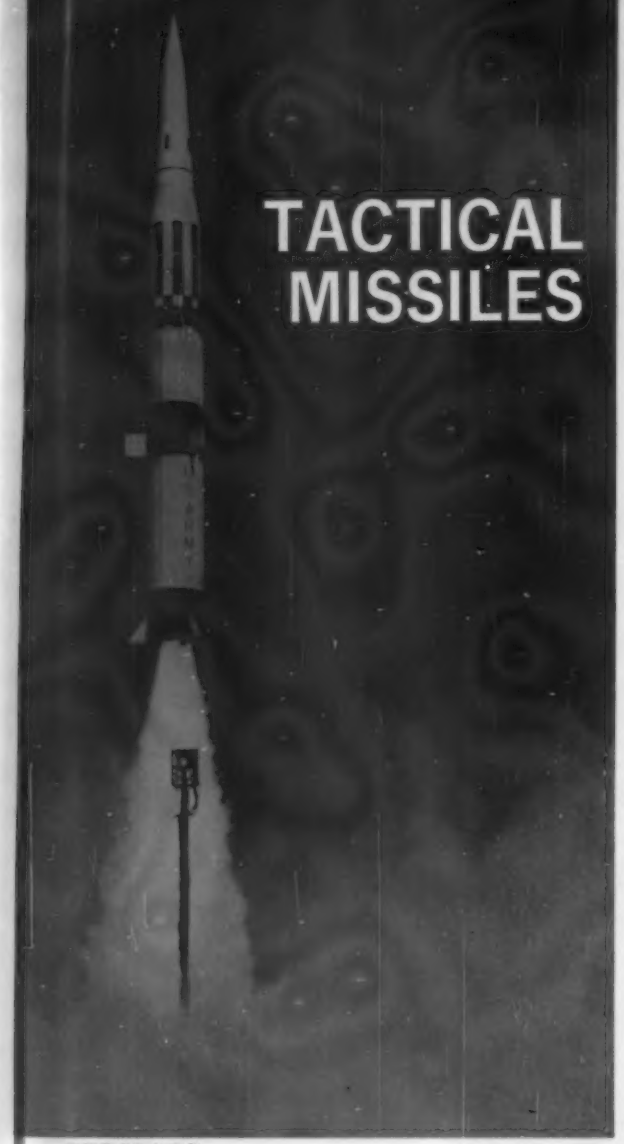
GUIDANCE: *System contractor*—Nortronics. *Type*—stellar-inertial.

BOOSTER: *System contractor*—Aerojet. *Propellant*—solid.

SUSTAINER: *System contractor*—Aerojet. *Propellant*—solid.

RE-ENTRY VEHICLE: *System contractor*—General Electric. *Warhead type*—nuclear.

TACTICAL MISSILES



PERSHING

REDSTONE

The U.S. and its allies are proceeding with a buildup of tactical-missile muscle that will greatly increase the firepower of the individual soldier.

Mobility continues to be a major problem—and the military is pressing industry for lighter and simpler GSE.

Even so, introduction of Sergeant and Little John—and the coming deployment of nuclear-tipped Davy Crocketts and the Pershing—will provide the infantryman with the most potent and effective artillery ever seen on a battlefield.

SURFACE-TO-SURFACE

PERSHING (Army)

TYPE: Surface-to-surface

STATUS: Late R&D

PRIME CONTRACTOR: The Martin Co.

PERFORMANCE: *Range*—350 n. miles. *Speed*—supersonic.

DEPLOYMENT: *Location*—to replace Redstone. *Initially operational:* about late 1961.

FRAME: *System contractor*—Martin. *Length*—34 ft. *Diameter*—40 in.

GUIDANCE: *System contractor*—Bendix. *Type*—inertial.

BOOSTER: *System contractor*—Thiokol. *Propellant*—solid.

SUSTAINER: *System contractor*—Thiokol. *Propellant*—solid.

PAYLOAD: *Warhead type*—nuclear.

G.S.E.: *Transporter-erector-launcher*—Thompson Ramo Wooldridge. *Handling and services*—Thompson Ramo Wooldridge. *Vehicles*—Food Machinery.

REMARKS: Range could be greatly increased if desired. First R&D launching Feb. 25, 1960 from Cape Canaveral, Fla.

REDSTONE (Army)

MILITARY DESIGNATION: SSM-5

TYPE: Surface-to-surface

STATUS: Operational

PRIME CONTRACTOR: Chrysler Corp.

PERFORMANCE: *Range*—200 n. miles. *Speed*—3800 mph. *Apogee*—55 miles.

DEPLOYMENT: *Location*—U.S. troops in Germany. *Initially operational*—1958.

FRAME: *System contractor*—Reynolds Metals. *Length*—70 ft. *Diameter*—5.5 ft. *Launch weight*—62,000 lbs. *Material* (major)—aluminum.

GUIDANCE: *System contractor*—Ford Instrument. *Type*—inertial.

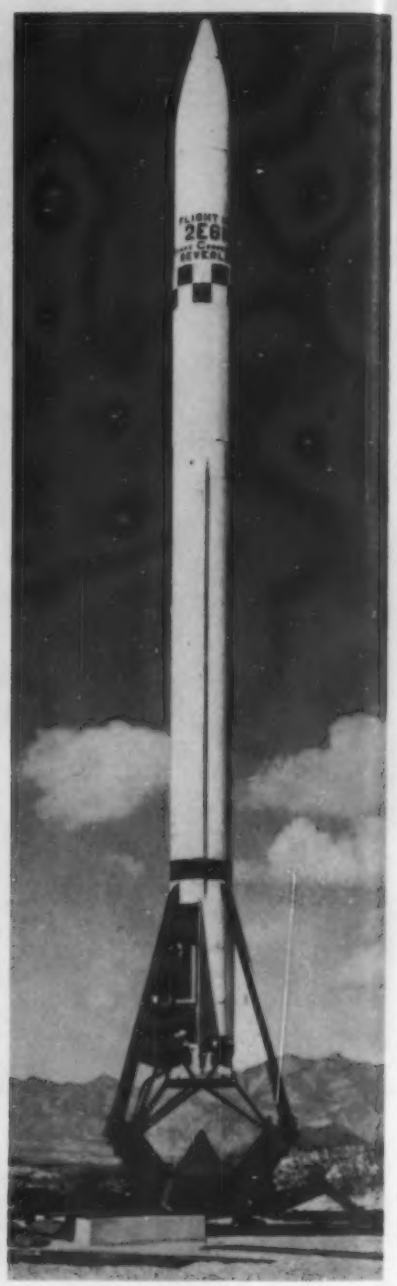
BOOSTER: *System contractor*—North American Aviation. *Propellant*—Liquid. *Thrust*—78,000 lbs.

PAYLOAD: *Warhead type*—nuclear or HE.

G.S.E.: *Launcher*—Chrysler. *Fueling*—Chrysler. *Handling and service*—Chrysler. *Transport vehicles*—Chrysler.

REMARKS: To be replaced by Pershing. Redstones are being used in the Mercury program by NASA for early equipment and manned test flights.

SERGEANT



CORPORAL

SERGEANT (Army)

MILITARY DESIGNATION: SSM-A26

TYPE: Surface-to-surface

STATUS: Nearly operational

PRIME CONTRACTOR: Sperry Utah Engineering Lab.

PERFORMANCE: *Range*—85 miles. *Speed*—supersonic.

DEPLOYMENT: *Location* — to replace Corporal. *Initially operational*—1961.

FRAME: *System contractor*—Sperry. *Length*—35 ft. *Diameter*—31 in. *Launch weight*—10,000 lbs. *Material (major)*—steel and aluminum.

GUIDANCE: *System contractor*—Sperry. *Type*—inertial.

BOOSTER: *System contractor*—Sperry. *Propellant*—solid. *Thrust*—about 55,000 lbs.

PAYLOAD: *Warhead type* — nuclear or HE.

G.S.E.: *Launcher*—Temco Aircraft. *Fueling* — Thiokol. *Handling and service* — Sperry. *Transport vehicles*—Fruehauf.

CORPORAL (Army)

MILITARY DESIGNATION: M-2

TYPE: Surface-to-surface

STATUS: Operational

PRIME CONTRACTOR: Firestone Tire & Rubber Co./Gilfillan Bros.

PERFORMANCE: *Range*—75 miles. *Speed*—Mach 3.

DEPLOYMENT: *Location*—U.S. troops in Europe. *Battalion strength* — two launchers; two batteries (one firing, the other service). *Initially operational*—late 1953.

FRAME: *System contractor*—Firestone. *Length*—45 ft. *Diameter*—30 in. *Launch weight*—11,000 lbs. *Material (major)*—steel.

GUIDANCE: *System contractor*—Gilfillan. *Type*—preset and command.

BOOSTER: *System contractor*—Ryan. *Propellant*—nitric acid and aniline.

PAYLOAD: *Warhead type* — nuclear or HE.

G.S.E.: *Launcher*—Firestone. *Fueling* — Firestone. *Handling and service*—Firestone.

REMARKS: To be replaced by the solid-propelled Sergeant.

LITTLE JOHN (Army)

MILITARY DESIGNATION: M-51

TYPE: Surface-to-surface

STATUS: Operational

PRIME CONTRACTOR: Emerson Electric Co.

PERFORMANCE: *Range*—10 miles. *Speed*—supersonic.

DEPLOYMENT: *Location* — missile in hands of training units in the United States. *Initially operational*—1960. *Battalion strength*—four launchers.

FRAME: *System contractor* — Emerson Electric. *Length*—14 ft. 5 in. *Diameter*—12.5 in. *Launch weight*—780 lbs. *Material (major)*—steel and aluminum.

GUIDANCE: *Type*—free-flight ballistic missile.

BOOSTER: *System contractor* — Army Ordnance Missile Command/ Hercules Powder. *Propellant* — solid.

PAYLOAD: *Warhead type* — nuclear or HE.

G.S.E.: *Launcher* — Rock Island Arsenal.

REMARKS: A highly mobile and easily airlifted missile.

LITTLE JOHN

HONEST JOHN

HONEST JOHN (Army)

MILITARY DESIGNATION: M-31

TYPE: Surface-to-surface

STATUS: Operational

PRIME CONTRACTOR: Douglas Aircraft Co./Emerson Electric

PERFORMANCE: *Range*—12 miles. *Speed*—Mach 1.7.

DEPLOYMENT: *Location*—U.S. forces in continental United States, Europe and the Far East. Also in the hands of U.S. NATO allies. *Initially operational* — late 1953. *Battalion strength*—four launchers.

FRAME: *System contractor*—Douglas/Emerson. *Length*—27 ft. *Diameter*—30 in. *Launch weight*—5800 lbs. *Material (major)*—steel.

GUIDANCE: *Type*—free-flight ballistic missile.

BOOSTER: *System contractor*—Hercules Powder. *Propellant* — solid.

SPIN ROCKETS: *System contractor* —Thiokol. *Propellant*—solid.

PAYLOAD: *Warhead type* — nuclear or HE.

G.S.E.: *Launcher* — Rock Island Arsenal.

REMARKS: Douglas is producing an Improved Honest John made of aluminum with a solid booster (XM-50). The improved version has a range of more than 12 miles, weighs 1000 lbs. less and is three inches shorter.

DAVY CROCKETT (Army)

MILITARY DESIGNATION: XM-388

TYPE: Surface-to-surface

STATUS: Nearly operational

PRIME CONTRACTOR: Rock Island, Ill., Arsenal

PERFORMANCE: Launched from either two tube-shaped launchers (XM-28 and XM-29) of varying size for different ranges. Range is relatively short.

DEPLOYMENT: *Location*—U.S. troops overseas and in continental United States; also NATO allies. *Initially operational*—1962.

BOOSTER: *Propellant*—solid.

PAYLOAD: *Warhead type* — nuclear (fractional yield).

REMARKS: Smaller launcher can be carried by two men. Crockett is inserted into its launcher in the same fashion as a rifle grenade. The warhead is larger than the tube.

DAVY CROCKETT

MISSILE A (Army)

TYPE: Surface-to-surface

STATUS: R&D

PRIME CONTRACTOR: None announced

PERFORMANCE: *Range* — about 10-20 miles.

FRAME: *Launch weight* — under 500 lbs.

REMARKS: The Army Rocket and Guided Missile Agency at Huntsville, Ala., is acting as systems manager for a series of components that have been under development.

MACE

MATADOR

MACE (Air Force)

MILITARY DESIGNATION: TM-76A and TM-76B

TYPE: Air-breathing surface-to-surface

STATUS: TM-76A operational. TM-76B flight-testing.

PRIME CONTRACTOR: The Martin Co.

PERFORMANCE: *Range*—*(A)* more than 650 n. miles. *(B)* more than 1200 n. miles. *Speed*—*(A)* more than 650 mph. *(B)* same but supersonic in terminal dive. *Ceiling*—more than 40,000 ft.

DEPLOYMENT: *Location*—*(A)* U.S. troops in West Germany. *Initially operational*—*(A)* 1960. *Total divisions*—at least two. *Divisional strength*—about 50. *(B)* to be deployed on Okinawa.

FRAME: *System contractor*—Martin. *Length*—44 ft. *Diameter*—54 in. *Wingspan*—22.9 ft. *Launch weight*—15,500 lbs. *Material (major)*—aluminum and magnesium

GUIDANCE: *System contractor*—*(A)* Goodyear. *(B)* A.C. Spark Plug. *Type (A)*—ATRAN map-matching. *(B)* inertial.

BOOSTER: *System contractor*—Thiokol. *Propellant*—solid (JATO). *Thrust*—100,000 lbs.

SUSTAINER: *System contractor*—Allison. *Engine*—J-33-41. *Thrust*—5200 lbs.

G.S.E.: *Launcher*—*(A)* Goodyear. *(B)* Martin. *Fueling*—Martin. *Handling and service*—*(A)* Goodyear/Martin/Four Wheel Drive Auto Co. *(B)* Martin, A.C. Spark Plug. *Transport vehicles*—*(A)* Four Wheel Drive. *(B)* Martin.

MATADOR (Air Force)

MILITARY DESIGNATION: TM-61C

TYPE: Air-breathing surface-to-surface

STATUS: Operational

PRIME CONTRACTOR: The Martin Co.

PERFORMANCE: *Range*—500 n. miles. *Speed*—about 650 mph. *Ceiling*—more than 40,000 ft.

DEPLOYMENT: *Location*—U.S. troops in West Germany, Far East. Also in hands of NATO allies. *Initially operational*—October, 1951. *Total divisions*—three. *Divisional strength*—about 50.

FRAME: *System contractor*—Martin. *Length*—39.6 ft. *Diameter*—54 in. *Wingspan*—28.7 ft. *Launch weight*—12,500 lbs. *Material (major)*—aluminum and magnesium.

GUIDANCE: *System contractor*—Air Force. *Type*—radar control.

BOOSTER: *System contractor*—Thiokol. *Propellant*—solid (JATO). *Thrust*—57,000 lbs.

SUSTAINER: *System contractor*—Allison. *Engine*—J-33-37 turbo jet. *Thrust*—4200 lbs.

PAYLOAD: *Warhead type*—nuclear or HE.

G.S.E.: *Launcher*—Martin. *Fueling*—Martin. *Handling and service*—Martin. *Transport vehicles*—Martin.

REMARKS: Relatively mobile Matadors are being replaced by more advanced Maces. Matadors in West Germany are being turned over to German troops.

LACROSSE (Army)

MILITARY DESIGNATION: M4E2

TYPE: Surface-to-surface

STATUS: Operational

PRIME CONTRACTOR: The Martin Co.

PERFORMANCE: *Range*—20 miles. *Speed*—transonic.

DEPLOYMENT: *Location*—Two U.S. battalions in West Germany; five more in training in the United States. *Initially operational*—1959. *Total battalions*—seven. *Battalion strength*—four mobile launchers.

FRAME: *System contractor*—Martin. *Length*—19 ft. *Diameter*—20.5 in. *Launch weight*—2300 lbs.

GUIDANCE: *System contractor*—Martin. *Type*—command.

BOOSTER: *System contractor*—Thiokol. *Propellant*—solid.

PAYLOAD: *Warhead type*—nuclear or HE.

G.S.E.: *Launcher*—Martin. *Handling and service*—Martin.

LACROSSE

SHILLELAGH (Army)

TYPE: Surface-to-surface

STATUS: R&D

PRIME CONTRACTOR: Aeronutronic Division, Ford Motor Co.

PERFORMANCE: Designed to provide heavy firepower for close-in support of troops.

DEPLOYMENT: *Location*—to be deployed with U.S. combat troops. *Initially operational*—mid-1960's.

FIRE CONTROL: *System contractor*—Raytheon

PAYLOAD: *Warhead type*—nuclear.

REMARKS: There will be hand-carried and vehicle-mounted versions.

M-55 (Army)

TYPE: Surface-to-surface

STATUS: Operational

PRIME CONTRACTOR: Norris Thermador Co.

PERFORMANCE: *Range*—relatively short. Launched from 45-tube T-145 launcher.

DEPLOYMENT: *Location*—U.S. combat troops in the United States and overseas. *Initially operational*—1960.

FRAME: *Diameter*—115 mm.

GUIDANCE: *Type*—free-flight.

BOOSTER: *Propellant*—solid.

PAYLOAD: *Warhead type*—chemical agents.

ADVANCED TACTICAL MISSILES

Project	Contractors	Description	Status
ARM (Navy)	No contracts announced	Air-to-surface anti-radar missile	R&D
COBRA (Navy)	No contracts announced	Anti-ship, anti-radar missile	R&D
GIMLET (Navy)	No contracts announced	Air-to-surface unguided, considered highly accurate	R&D
GPSSM (Army)	No contracts announced	General-purpose surface-to-surface missile	Study
LOBBER (Army)	No contracts announced	Surface-to-surface cargo carrier; 10-15 m. range; also can drop napalm	Study
RAVEN (Navy)	No contracts announced	Air-to-surface; about 500 m. range	Study
WAGTAIL (Air Force)	Minneapolis-Honeywell-prime	Family of RLM (Rearward Launched Missiles) launched from aircraft for various applications such as air-to-surface and air-to-air; inertial; finless.	Late R&D
WILLOW (Army)	Chrysler, prime	No details available	

AIR-TO-SURFACE

BULLPUP (Navy and Air Force)

MILITARY DESIGNATION: ASM-N-7A and B and GAM-83A and B

TYPE: Air-to-surface

STATUS: A models operational, B in late R&D

PRIME CONTRACTOR: The Martin Co./Maxson Corp. (second source)

PERFORMANCE: *Range*—three to 6 n. miles. *Speed*—Mach 1.8

DEPLOYMENT: *Location*—U.S. carriers, Marine Corps units and the Tactical Air Command. *Initially operational*—April, 1959, aboard the Carrier Lexington.

FRAME: *System contractor*—Martin. *Length*—11 ft. (A). *Diameter*—about 1 ft. (A). *Launch weight*—571 lbs. (A). *Material (major)*—aluminum.

GUIDANCE: *System contractor*—Martin. *Type*—command (visual reference).

BOOSTER: *System contractor*—Allegany Ballistics Lab and Thiokol. *Type*—solid and packaged liquid (Guardian).

PAYLOAD: *Warhead type*—HE (250-1000 lb.) or nuclear.

REMARKS: Navy and Air Force A models identical; Navy B carries larger HE warhead, AF B has nuclear warhead.

ADVANCED BULLPUP

ANTITANK

COBRA

COBRA (Marines)

TYPE: Antitank

STATUS: Operational

PRIME CONTRACTOR: Boelkow Entwicklungen, Munich, Germany, and Daystrom, Inc.

PERFORMANCE: *Range*—5940 ft. (max.); 5280 ft. (effective). *Speed*—191 mph.

DEPLOYMENT: *Location* — Marine evaluation units. Also see Foreign Missiles Section.

FRAME: *System contractor*—Boelkow (Europe); not determined for U.S. *Length*—30.7 in. *Diameter*—3.9 in. *Height*—13.6 in. *Wingspan* — 19 in. *Launch weight* — 20.2 lbs. *Material (major)*—plastic

GUIDANCE: *System contractor*—Boelkow (Europe); Daystrom (U.S.) *Type*—wire.

BOOSTER: *System contractor*—Oerlikon (Europe). Not determined for U.S. *Propellant*—solid.

PAYLOAD: *Warhead type*—armor-piercing HE (5.5 lbs.)

REMARKS: Missile can be launched and guided by one man.

SS-10

SS-10 (Army)

TYPE: Antitank

STATUS: Operational

PRIME CONTRACTOR: Nord Aviation, Paris, France; General Electric Co. (U.S. licensee)

PERFORMANCE: *Range*—5250 ft. (effective). *Speed*—180 mph.

DEPLOYMENT: *Location*—U.S. Army combat units (launched from jeeps, helicopters and other mobile vehicles). Also see Foreign Missiles section.

FRAME: *System contractor*—Nord (GE secondary source). *Length*—34 in. *Diameter*—6 in. *Wingspan*—30 in. *Launch weight*—33 lbs.

GUIDANCE: *System contractor*—Nord. *Type*—wire.

BOOSTER: *System contractor*—Nord. *Propellant*—solid.

PAYLOAD: *System contractor*—Strim. *Warhead type* — armor-piercing HE.

REMARKS: Initial U.S. Army procurement began in April, 1959. SS-10 can be carried and launched by one man. Army now phasing out stockpile and buying Entacs.

SS-11

SS-11 (Army)

TYPE: Antitank

STATUS: Operational

PRIME CONTRACTOR: Nord Aviation, Paris, France

PERFORMANCE: *Range* — 1650-11,500 ft. (effective). *Speed* — more than 400 mph.

DEPLOYMENT: *Location* — under evaluation by Army units. Also see Foreign Missiles section.

FRAME: *System contractor*—Nord. *Length*—46 in. *Diameter*—6 in. *Wingspan*—20 in. *Launch weight*—62 lbs.

GUIDANCE: *System contractor*—Nord. *Type*—wire.

BOOSTER: *System contractor*—Nord. *Propellant*—solid.

PAYLOAD: *System contractor* — Strim. *Warhead type* — armor-piercing HE.

LAW

LAW (Army)

TYPE: Antitank

STATUS: R&D

PRIME CONTRACTOR: Hesse-Eastern Division of Flightex Fabrics Inc.

PERFORMANCE: *Range* — 10-500 yds.

DEPLOYMENT: Intended for use by infantrymen.

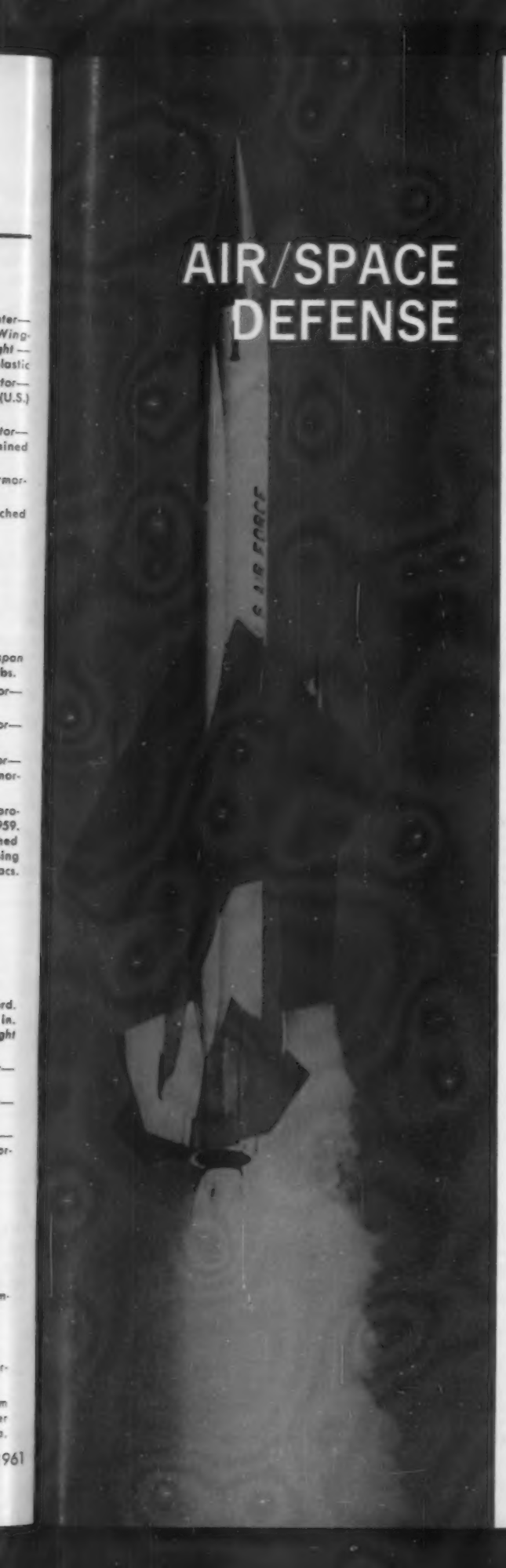
FRAME: *Length*—20.8 in. *Diameter*—about 3.1 in.

GUIDANCE: Unguided

BOOSTER: *Type*—solid

PAYLOAD: *Warhead type*—armor-piercing HE

REMARKS: Missile is fired from shoulder-held tubular launcher similar to World War II Bazooka.



AIR/SPACE DEFENSE

The search goes on for a feasible defense against missiles and spacecraft.

A question mark still hovers over Nike-Zeus, the only fully R&D-funded U.S. anti-ICBM, which is awaiting tests against warheads in 1962 before a decision is made whether to commit it to production.

Deployment of Nike-Hercules and Bomarc antiaircraft missiles is expected to be completed in 1962.

ANTIAIRCRAFT

BOMARC A (Air Force)

MILITARY DESIGNATION: IM-99A

TYPE: Air-breathing surface-to-air

STATUS: Operational

PRIME: Boeing Co.

PERFORMANCE: *Range* — 250 n. miles. *Speed*—supersonic. *Ceiling*—more than 68,000 ft.

DEPLOYMENT: *Location*—McGuire AFB, N.J.; Suffolk County AFB, N.Y.; Otis AFB, Mass.; Dow AFB, Maine; and Langley AFB, Va. *Initially operational*—1959. *Total bases planned*—five. *Total squadrons planned* — five. *Squadron strength*—average about 40 missiles.

FRAME: *System contractor*—Boeing. *Length*—47 ft. *Diameter*—35 in. *Wingspan*—18 ft. *Launch weight*—15,000 lbs. *Material (major)*—stainless steel.

GUIDANCE: *System contractor*—IBM and Westinghouse. *Type*—command and homing radar. (IBM SAGE guides missile to vicinity of target when homing radar assumes command.)

BOOSTER: *System contractor*—Aerojet. *Propellant*—liquid.

SUSTAINER: *System contractor*—Marquardt. *Engine* — (2) RJ-43 ramjets.

PAYLOAD: *Warhead type* — nuclear or HE.

G.S.E.: *Launcher-erector* — Food Machinery.

BOMARC B (Air Force)

MILITARY DESIGNATION: IM-99B

TYPE: Air-breathing surface-to-air

STATUS: Operational

PRIME: Boeing Co.

PERFORMANCE: *Range* — 400 n. miles. *Speed*—supersonic. *Ceiling*—more than 70,000 ft.

DEPLOYMENT: *Location* — continental United States (Duluth, Minn.; Niagara Falls, N.Y.; Kincheloe AFB, Mich.; Langley AFB, Va.; McGuire AFB, N.J.; Otis AFB, Mass.) and Canada. *Initially operational*—1961. *Total squadrons*—(U.S.) 6; (Canada) 2. *Total bases planned*—8. *Squadron strength*—28.

FRAME: *System contractor*—Boeing. *Length*—45 ft. *Diameter*—35 in. *Wingspan*—18 ft. *Launch weight*—16,000 lbs. *Material (major)*—stainless steel.

GUIDANCE: *System contractor*—IBM and Westinghouse. *Type*—command and radar homing. (IBM SAGE guides missile to vicinity of target, when homing radar takes command.)

BOOSTER: *System contractor*—Thiokol. *Propellant*—solid.

SUSTAINER: *System contractor*—Marquardt. *Engine*—(2) RJ-43 advanced ramjets.

PAYLOAD: *Warhead type* — nuclear or HE.

G.S.E.: *Launcher-erector* — Food Machinery.

REMARKS: Original number of squadrons planned was sharply cut. Bomarc B in March 1961 intercepted simulated supersonic target at 100,000 ft. and range of 446 s. miles.

NIKE-HERCULES

NIKE-AJAX

HAWK

NIKE-HERCULES (Army)

MILITARY DESIGNATION: SAM-A-25

TYPE: Surface-to-air (anti-missile capability)

STATUS: Operational

PRIME CONTRACTOR: Western Electric Co.

PERFORMANCE: *Range* — more than 75 n. miles. *Speed*—Mach 3 plus. *Ceiling*—more than 150,000 ft.

DEPLOYMENT: *Location*—United States, Western Europe, Far East. *Initially operational*—mid-1958. *Total battalions*—about 20. *Battalion strength*—4 batteries. *Battery strength*—9 launchers. *Total launchers*—more than 700.

FRAME: *System contractor*—Douglas. *Length*—39 ft. *Diameter*—31.5 in. *Wingspan*—90 in. *Launch weight*—10,000 lbs. *Material (major)*—aluminum and steel.

GUIDANCE: *System contractor*—Western Electric. *Type*—command.

BOOSTER: *System contractor*—Hercules Powder. *Propellant*—solid.

SUSTAINER: *System contractor*—Thiokol. *Propellant*—solid.

PAYLOAD: *Warhead type*—nuclear or HE.

G.S.E.: *Launchers*—Consolidated Western Steel. *Transport vehicles*: Fruehauf.

REMARKS: New General Electric radars give Nike-Hercules the capability of intercepting incoming tactical missiles. The Army plans to install improved system in Europe and other appropriate areas. The Army also is expected to build mobile Nike-Hercules anti-missile batteries for deployment in the field.

NIKE-AJAX (Army)

MILITARY DESIGNATION: SAM-A-7

TYPE: Surface-to-air

STATUS: Operational

PRIME CONTRACTOR: Western Electric Co.

PERFORMANCE: *Range*—25 miles. *Speed*—Mach 2.5. *Ceiling*—60,000 ft.

DEPLOYMENT: *Location*—United States, Western Europe, Far East. *Initially operational*—1953. *Total battalions*—about 40. *Battalion strength*—4 batteries. *Battery strength*—9 launchers. *Total launchers*—nearly 1500.

FRAME: *System contractor*—Douglas. *Length*—31 ft. *Diameter*—12 in. *Wingspan*—52 in. *Launch weight*—2300 lbs. *Material (major)*—aluminum and steel.

GUIDANCE: *System contractor*—Western Electric. *Type*—command.

BOOSTER: *System contractor*—Thiokol. *Propellant*—solid.

SUSTAINER: *System contractor*—Thiokol. *Propellant*—liquid.

PAYLOAD: *Warhead type*—HE.

G.S.E.: *Launchers*—Consolidated Western Steel. *Transport vehicles*—Fruehauf.

REMARKS: Nike-Ajax is being replaced by the far more advanced Nike-Hercules.

HAWK (Army)

MILITARY DESIGNATION: XM3E1

TYPE: Surface-to-air

STATUS: Operational

PRIME CONTRACTOR: Raytheon Co.

PERFORMANCE: *Range*—about 22 n. miles. *Speed* — Mach 2 plus. *Ceiling*—tree-top level to about 40,000 ft. (Hawk is specifically designed for use against low-flying aircraft.)

DEPLOYMENT: *Location*—U.S. troops training with Hawks in the United States. *Initially operational*—1959. *Battalions*—2. *Battalion strength*—3 to 5 batteries. *Battery strength*—6 to 12 launchers (3 missiles per launcher). Also to be used by Marine Corps and NATO allies. To be deployed in Europe, Far East and Panama.

FRAME: *System contractor*—Raytheon/Northrop. *Length* — 17 ft. *Diameter*—14 in. *Wingspan*—48 in. *Launch weight*—1275 lbs. *Material (major)*—aluminum and steel.

GUIDANCE: *System contractor*—Raytheon. *Type*—semi-active radar homing.

BOOSTER: *System contractor*—Aerojet. *Propellant*—solid.

SUSTAINER: *System contractor*—Aerojet. *Propellant*—solid.

PAYLOAD: *Warhead type*—HE.

G.S.E.: *Launcher*—Northrop. *Handling and service* — Raytheon/Northrop / Food Machinery / and RCA. *Transport vehicles* — Food Machinery.

REMARKS: Although Hawk is not an anti-missile missile, it has successfully intercepted an Honest John, Little John and Corporal in tests. Hawk is highly mobile.

TALOS (Navy)

MILITARY DESIGNATION: SAM-N-6

TYPE: Surface-to-air and surface-to-surface (seagoing)

STATUS: Operational

PRIME CONTRACTOR: The Bendix Corp. *System engineer* — Vitro Corp.

PERFORMANCE: *Range* — more than 65 n. miles. *Speed*—about Mach 2.5. *Ceiling*—extremely high altitude.

DEPLOYMENT: *Location*—aboard the missile cruiser Galveston. To be deployed aboard at least six more cruisers including the nuclear-powered cruiser Long Beach. *Initially operational*—1959.

FRAME: *System contractor*—McDonnell. *Length*—about 30 ft. *Diameter*—about 30 in. *Launch weight*—7000 lbs. (booster alone weighs 4000 lbs.) *Material (major)*—steel.

GUIDANCE: *System contractor*—Bendix/Sperry. *Type*—beam riding.

BOOSTER: *System contractor*—Allegany Ballistics Lab. *Type*—solid.

SUSTAINER: *System contractor*—Allegany. *Type*—ramjet.

PAYLOAD: *Warhead type*—nuclear or HE.

G.S.E.: *Launchers*—Naval Weapons Plant.

REMARKS: Improvements in the Talos system have led to work on the anti-missile system called Typhon.

TALOS

TERRIER (Navy)

MILITARY DESIGNATION: SAM-N-7.

TYPE: Surface-to-air and surface-to-surface (seagoing).

STATUS: Operational.

PRIME CONTRACTOR: Convair Division, General Dynamics Corp. *System engineer*—Vitro Corp.

PERFORMANCE: *Range*—about 10 n. miles. *Speed*—supersonic. *Ceiling*—more than 50,000 ft.

DEPLOYMENT: *Location*—aboard 20 ships including the Long Beach and the carrier Enterprise. Also used in a mobile version by Marines. *Initially operational*—1956.

FRAME: *System contractor*—Convair. *Length*—27 ft. (with 15 ft. booster). *Diameter*—12 in. *Launch weight*—about 3000 lbs.

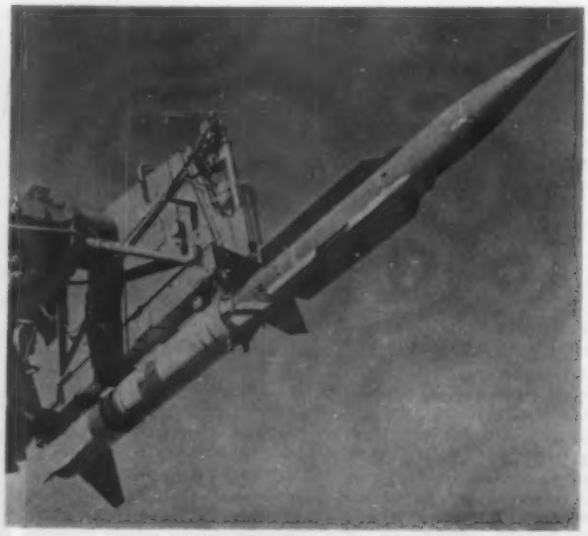
GUIDANCE: *System contractor*—Reeves/FTL/Sperry. *Type*—radar beam rider.

BOOSTER: *System contractor*—Allegany Ballistics Lab. *Propellant*—solid.

SUSTAINER: *System contractor*—Allegany Ballistics Lab. *Propellant*—solid.

PAYLOAD: *Warhead type*—HE.

REMARKS: Terrier is being replaced by the Convair Advanced Terrier. The Advanced Terrier's performance is about 100% greater than Terrier's. The Frigate Dewey is the first ship to be armed with Advanced Terrier.



TERRIER

TARTAR (Navy)

MILITARY DESIGNATION: Mark 15.

TYPE: Surface-to-air (seagoing)

STATUS: Operational.

PRIME CONTRACTOR: Convair Division, General Dynamics Corp. *System engineer*—Vitro Corp.

PERFORMANCE: *Range* — more 10 n. miles. *Speed*—supersonic. *Ceiling*—high-altitude.

DEPLOYMENT: *Location*—to be installed aboard 13 destroyers. *Initially operational*—1961.

FRAME: *System contractor*—Convair. *Length*—15 ft. *Diameter*—12 in. *Launch weight*—about 1500 lbs.

GUIDANCE: *System contractor*—Raytheon.

BOOSTER: *System contractor*—Aerojet. *Propellant*—solid.

PAYLOAD: *Warhead type*—HE.

G.S.E.: *Launcher*—Puget Sound Naval Shipyard. *Handling*—Washington Technological Associates/Naval Weapons Plant.

TARTAR

REDEYE

REDEYE (Army)

TYPE: Surface-to-air (shoulder-launched)

STATUS: Nearly operational

PRIME CONTRACTOR: Convair Division, General Dynamics Corp.

PERFORMANCE: Designed to intercept low-flying jet aircraft. One man can operate and carry.

DEPLOYMENT: *Location*—to be deployed with Army and Marine combat troops. *Initially operational*—1962.

FRAME: *System contractor*—Convair. *Length*—4 ft. *Diameter*—3 in. *Launch weight*—20 lbs.

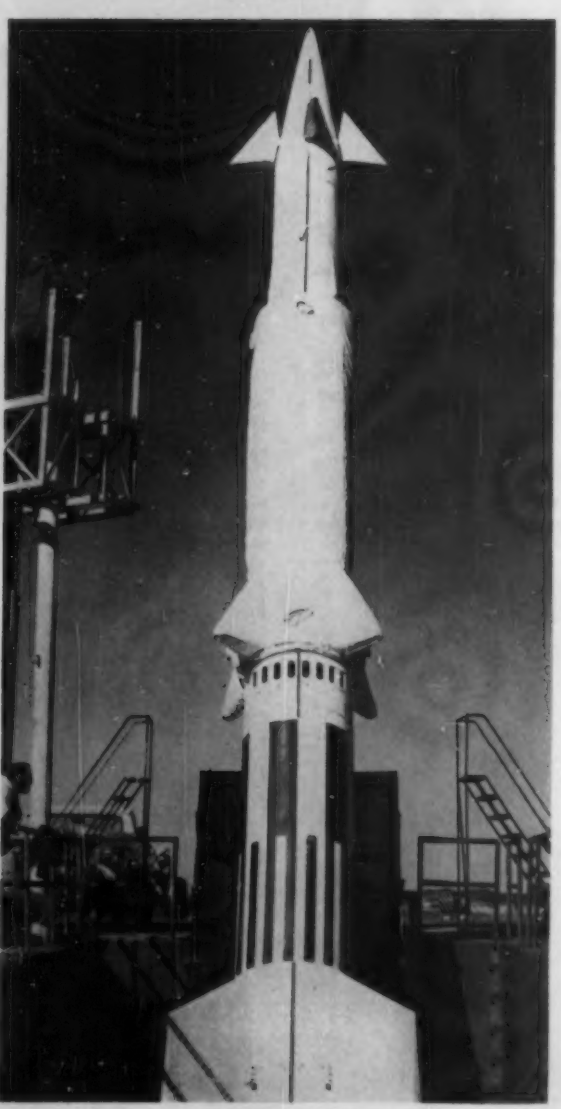
GUIDANCE: *System contractor*—Philco/Convair. *Type*—Infrared.

BOOSTER: *System contractor*—Atlantic Research. *Propellant*—solid.

PAYLOAD: *Warhead type*—HE.

REMARKS: Redeye is shipped, carried and launched from a disposable bazooka-shaped container. Program slipped.

ANTIMISSILE



NIKE-ZEUS

NIKE-ZEUS (Army)

TYPE: Surface-to-air anti-ICBM and IRBM.

STATUS: Late R&D

PRIME CONTRACTOR: Western Electric Co.

PERFORMANCE: *Range* — about 200 n. miles. *Speed*—est. Mach 4

DEPLOYMENT: *Location*—continental United States (particularly around soft SAC bases). *Initially operational*—about 1965. *Total batteries*—undetermined. *Battery strength*—to vary from about 30-50 launchers.

FRAME: *System contractor*—Douglas. *Length*—about 65 ft. *Diameter*—about 5 ft.

GUIDANCE: *System contractor*—Western Electric. *Type*—command.

BOOSTER: *System contractor*—Thiokol. *Propellant*—solid.

SUSTAINER: *System contractor*—Grand Central. *Propellant*—solid.

PAYLOAD: *Warhead type*—nuclear.

G.S.E.: *Launcher*—Douglas. *Handling and service*—Douglas.

REMARKS: The future of the Nike-Zeus system is in doubt. Both the Eisenhower and Kennedy Administrations have refused to permit the Army to begin production, thereby causing deployment to slip. However, plans for flight-testing the missile in the Pacific in late 1961 or early 1962 against Atlases have been approved.

MAULER (Army)

TYPE: Surface-to-air (anti-missile missile)

STATUS: R&D

PRIME CONTRACTOR: Convair Division, General Dynamics Corp.

PERFORMANCE: Designed to intercept incoming tactical missiles and jet aircraft.

DEPLOYMENT: *Location*—to be put in hands of Army combat units in near forward positions.

GUIDANCE: *Type*—radar.

BOOSTER: *Propellant*—solid.

REMARKS: Mauler will be launched from tracked vehicle manned by crew of only several men. System will be self-propelled and highly mobile and compact. Seagoing version has been proposed.

TYPHON (Navy)

TYPE: Surface-to-air (anti-missile missile)

STATUS: R&D

PRIME CONTRACTOR: Westinghouse Electric Corp./Applied Physics Lab.

PERFORMANCE: Designed to intercept both incoming tactical missiles and missiles launched from submerged submarines seconds after launching. *Range*—est. 100 n. miles. *Speed*—supersonic.

DEPLOYMENT: *Location*—aboard cruisers, destroyers and possibly hydrofoil destroyers.

BOOSTER: *Systems contractor*—Bendix.

PAYLOAD: *Warhead type*—nuclear or HE.

REMARKS: Two types are being developed—Long Range Typhon (formerly called Super Talos) and Medium Range Typhon (formerly called Super Tartar).

SIDEWINDERS on Northrop N156F

AIR-TO-AIR

SIDEWINDER (Navy-Air Force)

MILITARY DESIGNATION: AAM-N-7 (Navy) and GAR-8 (Air Force)

TYPE: Air-to-air.

STATUS: Operational.

PRIME CONTRACTOR: Philco Corp./General Electric Co.

PERFORMANCE: *Range*—about 2 n. miles. *Speed*—supersonic. *Ceiling*—more than 50,000 ft.

DEPLOYMENT: *Location*—carried by carrier-based Naval aircraft and Air Defense Command aircraft. Also widely used by U.S. allies. *Initially operational*—mid-1956.

FRAME: *System contractor*—Norris Thermador/Hunter-Douglas. *Length*—9 ft. *Diameter*—5 in. *Launch weight*—about 155 lbs. *Material (major)*—aluminum.

GUIDANCE: *System contractor*—Philco/GE. *Type*—Infrared.

BOOSTER: *System contractor*—Naval Propellant Plant. *Propellant*—solid.

PAYLOAD: *Warhead type*—HE.

REMARKS: Philco is prime contractor for Sidewinder I-C, a second-generation missile with greater speed and range. I-C will have switchable IR and radar homing warheads. The Naval Ordnance Test Station at China Lake, Calif., developer of Sidewinder, also is developing I-C.

ZUNI

ZUNI (Navy)

TYPE: Air-to-surface.

STATUS: Operational.

PRIME CONTRACTOR: Naval Ordnance Test Station, China Lake.

PERFORMANCE: *Range*—about 5 n. miles. *Speed*—about 3000 ft./sec.

DEPLOYMENT: *Location*—carrier-based aircraft. *Initially operational*—1957.

FRAME: *Length*—110 in. *Diameter*—5 in. *Launch weight*—107 lbs.

GUIDANCE: *Type*—free flight.

BOOSTER: *System contractor*—Hunter-Douglas. *Type*—solid. *Thrust*—7000 lbs.

PAYLOAD: *Warhead type*—HE (also variety of other conventional warheads including flares.)

REMARKS: The four-rocket launchers, which also are used for transporting and storing Zunis, can be jettisoned from plane after rockets are launched. AD-type Naval aircraft can carry up to 48 Zunis.

GENIE

GENIE (Air Force)

MILITARY DESIGNATION: MB-1

TYPE: Air-to-air.

STATUS: Operational.

PRIME CONTRACTOR: Douglas Aircraft Co.

PERFORMANCE: *Range*—about 6 n. miles. *Speed*—supersonic.

DEPLOYMENT: *Location*—aboard Air Defense Command aircraft (F-89's, F-101's, F-106's). *Initially operational*—about 1958.

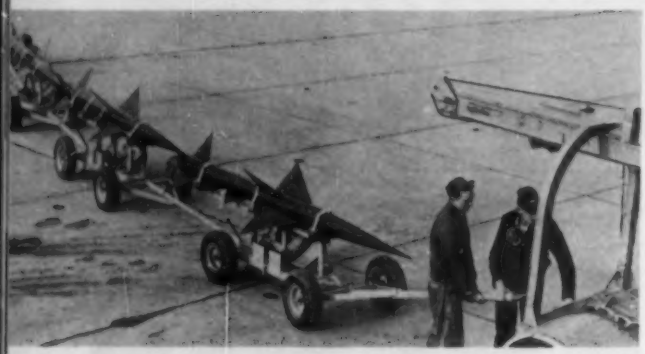
FRAME: *System contractor*—Douglas. *Length*—9.5 ft. *Launch weight*—about 800 lbs.

GUIDANCE: *Type*—free flight.

BOOSTER: *System contractor*—Aerojet. *Propellant*—solid.

PAYLOAD: *Warhead type*—nuclear.

G.S.E.: *Launcher*—Douglas. *Handling and service*—Douglas. *Transport vehicles*—Fruehauf.



SPARROW

SPARROW III (Navy)

MILITARY DESIGNATION: AAM-N-6A.

TYPE: Air-to-air.

STATUS: Operational.

PRIME CONTRACTOR: Raytheon Co.

PERFORMANCE: *Range* — more than 5 n. miles. *Speed*—more than Mach 2.

DEPLOYMENT: *Location*—carrier-based U.S. Navy aircraft. Also with Marine units. *Initially operational*—August, 1958, replacing Sparrow I.

FRAME: *System contractor*—Raytheon. *Length*—12 ft. *Diameter*—8 in. *Launch weight*—400 lbs. *Material (major)*—aluminum.

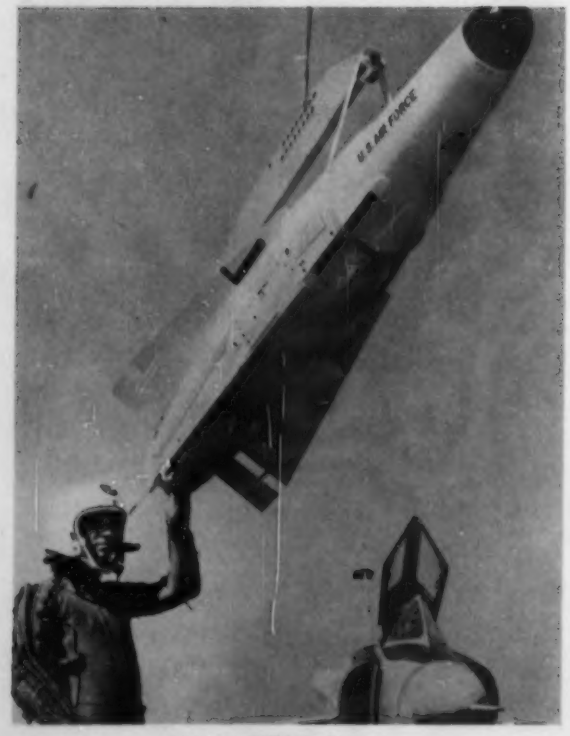
GUIDANCE: *System contractor*—Raytheon. *Type*—radar homing.

BOOSTER: *System contractor*—Aerojet. *Propellant*—solid (A new version of Sparrow with greater capability has Thiokol booster with packaged liquid propellant.) *Thrust (solid)*—7800 lbs.

PAYLOAD: *Warhead type*—HE.

G.S.E.: *Handling and service*—Raytheon.

REMARKS: Sparrow gave the Navy an all-weather missile when Sidewinder had only IR guidance.



FALCON GAR-11

FALCON (Air Force)

MILITARY DESIGNATION: GAR-1 through GAR-4 and GAR-11.

TYPE: Air-to-air.

STATUS: Operational (GAR-1 through GAR-4) and late R&D GAR-11).

PRIME CONTRACTOR: Hughes Aircraft Co.

PERFORMANCE: *Range*—about 5 n. miles. *Speed*—supersonic. (Greater ranges and speeds for GAR-3 and GAR-4, and GAR-11).

DEPLOYMENT: *Location*—Air Defense Command aircraft (F-89, F-101, F-102 and F-106). *Initially operational*—1957 (first versions). GAR-11 nearly operational.

FRAME: *System contractor*—Hughes. *Length*—about 6.5-7 ft. (GAR-11 is more than 7 ft.). *Diameter*—6.4 in. GAR-11 is 7 ft. 11 in.) *Wingspan*—20 in. *Launch weight*—more than 120 lbs. (GAR-11 is more than 200 lbs.).

GUIDANCE: *System contractor*—Hughes. *Type*—(GAR-1D and GAR-3) radar homing; (GAR-2 and GAR-4) infrared.

BOOSTER: *System contractor*—Thiokol. *Propellant*—solid.

PAYLOAD: *Warhead type*—(GAR-1 through GAR-4) HE; GAR-11 nuclear.

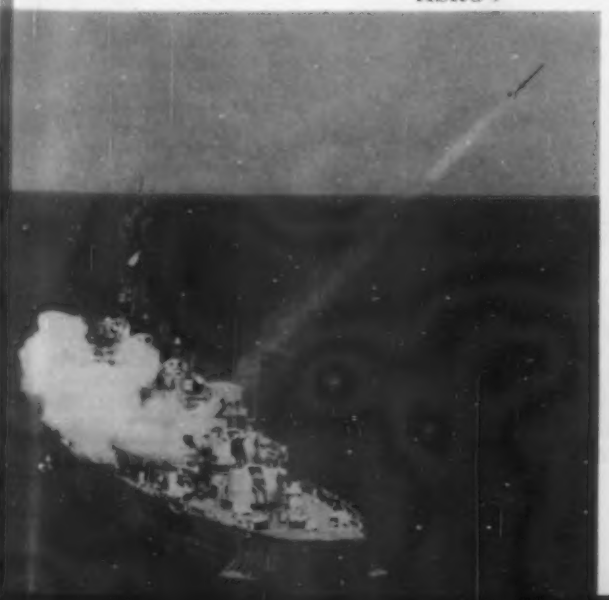
REMARKS: GAR-3 and GAR-4 are known as Super Falcons.

ANTI-SUBMARINE

WEAPON ALFA

SUBROC

ASROC



Missiles for attacking submarines have taken a great step forward. Asroc and Subroc—two of the most advanced ASW missiles—are now operational.

The stumbling block in ASW continues to be detection and identification. Any improvements in this area can be followed quickly by improved missiles.

WEAPON ALFA (Navy)

TYPE: ASW surface-to-underwater

STATUS: Operational

PRIME CONTRACTOR: Navy

PERFORMANCE: *Range* — about 900 yards.

DEPLOYMENT: *Location*—aboard U.S. destroyers and cruisers. *Initially operational*—1952

FRAME: *System contractor*—Avco. *Length*—8.5 ft. *Diameter*—12.75 in. *Launch weight*—500 lbs.

GUIDANCE: *Type*—free flight

BOOSTER: *Propellant*—solid

PAYLOAD: *Warhead type* — HE depth charge

REMARKS: Alfa is launched from guns mounted in turrets.

ASTOR (Navy)

TYPE: ASW rocket torpedo

STATUS: R&D

PRIME CONTRACTOR: Westinghouse Electric Corp.

PERFORMANCE: *Range*—reported to be about 11 n. miles.

DEPLOYMENT: *Location* — aboard U.S. fleet submarines.

FRAME: *System contractor*—Westinghouse. *Length*—nearly 20 ft. *Launch weight*—more than 2000 lbs.

GUIDANCE: *Type*—reported to be partly wire.

POWERPLANT: *Type*—reported to be electric and rocket-boosted. *Propellant*—solid.

PAYLOAD: *Warhead type* — nuclear or HE.

SUBROC (Navy)

TYPE: ASW underwater-to-underwater

STATUS: R&D

PRIME CONTRACTOR: Goodyear Aircraft Corp.

PERFORMANCE: *Range*—about 25 n. miles.

DEPLOYMENT: *Location* — aboard nuclear-powered attack submarines. Scheduled to be installed first aboard the Thresher. *Initially operational*—1961 or early 1962.

FRAME: *System contractor*—Goodyear.

GUIDANCE: *System contractor*—Kearfott.

FIRE CONTROL: *System contractor*—Librascope.

BOOSTER: *System contractor*—Thiokol. *Type*—solid.

PAYLOAD: *Warhead type* — nuclear or HE.

REMARKS: Subroc will be launched underwater from a conventional submarine tube, leave the water, travel through the air and reenter the water to strike an enemy submarine.

ASROC (Navy)

TYPE: ASW surface-to-underwater

STATUS: Operational

PRIME CONTRACTOR: Minneapolis-Honeywell Regulator Co.

PERFORMANCE: *Range*—about 8 n. miles. *Speed*—nearly Mach 1.

DEPLOYMENT: *Location*—Destroyer Leader Norfolk and Destroyer Peary. The Navy plans to install ASROC aboard a total of 150 destroyers and cruisers within the next few years. *Initially operational*—1960. *Launcher capacity*—eight. (Some ships will carry reloads).

FRAME: *System contractor*—Minneapolis-Honeywell. *Length*—15 ft. *Torpedo-warhead length*—100 in. *Missile diameter*—1 ft. *Overall diameter*—2.5 ft. *Launch weight*—about 1000 lbs.

FIRE CONTROL: *System contractor*—Librascope. *Type*—digital computer operated.

SONAR DETECTION: *System contractor*—Sangamo Electric. *Type*—SQS-23.

BOOSTER: *Propellant*—solid.

PAYLOAD: *Warhead* — General Electric Mark 44 acoustic homing torpedo or depth charge. *Type*—HE (depth charge can be nuclear).

G.S.E.: *Launcher*—Universal Match.

FOREIGN MISSILES

BLUE STEEL

Russia is believed to be improving and strengthening its ICBM and tactical missile forces. They also are reported working hard on an anti-ICBM.

NATO countries, meantime, are bringing out a number of improved tactical missiles. France is in the forefront with antitank and ASW missiles and the new air-to-surface AS-30. Britain is pushing its new tactical Blue Water—expected to be operational in 1963.

West Germany is a growing customer for tactical missiles, while France is making its own nuclear weapons in the buildup against Soviet might. The U.S. is buying some foreign missiles.

GREAT BRITAIN

BLUE STEEL (RAF)

TYPE: Air-to-surface (tactical)

STATUS: Production

PRIME CONTRACTOR: A. V. Roe & Co., Ltd. (Hawker Siddeley Group).

PERFORMANCE: *Range* — about 500 miles. *Speed*—Mach 12. *Ceiling*—about 60,000 ft.

DEPLOYMENT: *Location*—to be air-launched from British Vulcan bombers.

FRAME: *Length*—36 ft. *Wingspan*—about 13 ft. *Launch weight*—about 15,000 lbs.

GUIDANCE: *System contractor*—Elliott Bros. Ltd. *Type*-inertial.

POWERPLANT: *Propellant*—liquid

BOOSTER: *System contractor*—Bristol Siddeley Engines Ltd. *Propellant* — liquid. *Thrust* — 16,000 lbs.

PAYLOAD: *Warhead type*—nuclear or HE.

FIRESTREAK

FIRESTREAK (RAF)

TYPE: Air-to-air

STATUS: Operational

PRIME CONTRACTOR: de Havilland Aircraft Co. Ltd. (HSG)

PERFORMANCE: *Range*—about 5 miles. *Speed*—Mach 2.3.

DEPLOYMENT: *Location* — with RAF squadrons and air units of the Royal Navy.

FRAME: *Length*—10.5 ft. *Diameter*—8.5 in. *Launch weight*—300 lbs.

GUIDANCE: *Type*—infrared.

BOOSTER: *Type*—solid.

PAYLOAD: *Type*—HE.

BLUE STREAK (RAF)

TYPE: IRBM surface-to-surface.

REMARKS: Program cancelled 1960; booster development continued for possible space work.

BLOODHOUND I (RAF)

TYPE: Air-breathing surface-to-air.

STATUS: Operational.

PRIME CONTRACTOR: Bristol Aircraft Ltd. (British Aircraft Corp.).

PERFORMANCE: *Range*—about 35 miles. *Speed*—Mach 2.3.

DEPLOYMENT: *Location*—combat units in Britain and Australia. Also has been sold to Sweden.

FRAME: *Length*—25.3 ft. *Launch weight*—4500 lbs.

GUIDANCE: *System contractor*—Ferranti, Ltd. *Type*—radar homing.

BOOSTERS: *Type*—solid (4).

SUSTAINERS: *System contractor*—Bristol-Siddeley. *Engine* — Thor ramjets. *Thrust*—total 15,000 lbs.

REMARKS: Bristol Aircraft is developing an advanced version called Bloodhound II. It may have anti-missile capability.

BLUE WATER (Army)

TYPE: Surface-to-surface (tactical).

STATUS: Pre-production evaluation.

PRIME CONTRACTOR: English Electric Aviation Co., Ltd. (BAC).

PERFORMANCE: *Range* — about 80-100 miles.

DEPLOYMENT: None.

FRAME: *Length*—25 ft. *Diameter*—2 ft. *Wingspan*—6.9 ft. *Finspan*—6.5 ft.

GUIDANCE: Inertial.

BOOSTER: *Type*—solid.

PAYLOAD: *Warhead type*—nuclear or HE.

REMARKS: Highly mobile. Response time of 10 min. Expected to be operational in 1963. Being eyed for purchase by NATO; West Germany and Sweden.

SEACAT (Navy)

TYPE: Ship-to-air

STATUS: Operational.

PRIME CONTRACTOR: Short Bros. and Harland Ltd.

PERFORMANCE: *Range*—about 4 m. *Speed*—Mach 1.

DEPLOYMENT: *Location*—aboard Royal Naval destroyers and cruisers. Also ordered by West German, Swedish, Australian and New Zealand navies. *Initially operational*—1960.

GUIDANCE: *Type*—radio command.

FRAME: *Length*—4 ft. 10 in. *Wingspan*—2 ft.

BOOSTER: *Type*—solid.

SUSTAINER: *Type*—solid.

PAYLOAD: *Warhead type*—HE.

REMARKS: Four missiles on one battery.

THUNDERBIRD

BLUE WATER

THUNDERBIRD (Army)

TYPE: Surface-to-air

STATUS: Operational

PRIME CONTRACTOR: English Electric Aviation. Ltd. (BAC).

PERFORMANCE: *Range*—25 n. miles. *Speed*—about Mach 2.

DEPLOYMENT: *Location* — with British Army combat troops. *Initially operational*—1959.

GUIDANCE: *System contractor*—Marconi Instruments. *Type*—radar homing.

BOOSTER: *System contractor:* Bristol. *Type*—solid (4).

SUSTAINER: *System contractor:* I.C.I. *Type*—solid.

PAYLOAD: *Warhead type*—HE.

REMARKS: Launched from mobile carriers. Advanced Thunderbird with low-level capability and increased range entering production.

FAIREY A-T (Army)

TYPE: Surface-to-surface (anti-tank).

STATUS: Believed to be under development.

PRIME CONTRACTOR: Fairey Engineering, Ltd.

PERFORMANCE: Not available.

GUIDANCE: *Type*—reported to be radar.

PYTHON

TYPE: Surface-to-surface (anti-tank)

STATUS: RDT&E

PRIME CONTRACTOR: Pye, Ltd.

PERFORMANCE: Not available.

FRAME: *Length*—5 ft. *Fin span*—2 ft. *Launch weight*—80 lbs.

BOOSTER: *Propellant*—solid

GUIDANCE: *Type*—wire.

POWERPLANT: *Type*—2 stage solid.

REMARKS: Proposals submitted.

RED TOP (RAF)

TYPE: Air-to-air

STATUS: R&D

PRIME CONTRACTOR: de Havilland Aircraft Co. Ltd. (HSG)

PERFORMANCE: *Range*—about 9.5 miles. *Speed*—about Mach 3

DEPLOYMENT: *Location*—to replace Firestreak on various aircraft.

FRAME: *Length*—10.6 ft. *Wingspan*—3 ft. *Diameter*—8¾ in.

GUIDANCE: *Type*—infrared.

BOOSTER: *Type*—solid.

PAYLOAD: *Warhead type*—HE (68 lbs.).

REMARKS: Apparently designed within the same concept as the U.S. Navy's Eagle.

FIREFLASH (RAF)

TYPE: Air-to-air

STATUS: Operational (training)

PRIME CONTRACTOR: Fairey Aviation Ltd.

PERFORMANCE: *Range*—several miles. *Speed*—more than Mach 2.

DEPLOYMENT: *Location* — RAF squadrons use for training.

FRAME: *Length*—7 ft. 5 in. *Wingspan*—28.1 in. *Diameter*—5.5 in. *Launch weight*—300 lbs.

GUIDANCE: *Type*—beam riding.

BOOSTER: *Type*—solid. *Number*—two.

PAYLOAD: *Type*—HE.

REMARKS: Fireflash has been replaced as an operational missile by the Firestreak.

SEASLUG (Navy)

TYPE: Surface-to-air

STATUS: Operational

PRIME CONTRACTOR: W. G. Armstrong Whitworth Aircraft, Ltd. (HSG).

PERFORMANCE: *Range*—long.

DEPLOYMENT: *Location*—to be deployed aboard Navy guided missile destroyers. *Initially operational*—1961.

FRAME: *Length*—19.5 ft. *Diameter*—1.5 ft. *Wingspan*—4.5 ft.

GUIDANCE: *System contractor*—General Electric. *Type*—beam riding.

BOOSTER: *Type*—solid (4).

SUSTAINER: *Type*—solid.

PAYLOAD: *Warhead type*—HE (nuclear later).

TIGERCAT

TYPE: Surface-to-air

STATUS: R&D

PRIME CONTRACTOR: Short Brothers and Harland Co., Ltd.

PERFORMANCE: Designed as mobile anti-aircraft to be launched from armored carriers. Evolved from Seacat.

REMARKS: Under consideration by British Army.

VIGILANT

TYPE: Surface-to-surface (anti-tank)

STATUS: Under Army evaluation.

PRIME CONTRACTOR: Vickers-Armstrongs, Ltd. (BAC).

PERFORMANCE: *Range*—200 to 1700 yards. *Speed*—350 mph.

DEPLOYMENT: None. NATO countries considering.

FRAME: *Length*—3 ft. *Diameter*—4.5 in. *Launch weight*—about 26 lbs.

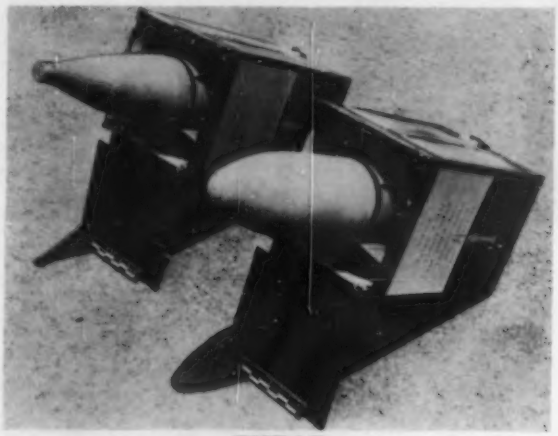
GUIDANCE: *Type*—wire, with gyro auto-pilot.

BOOSTER: *Propellant*—solid.

PAYLOAD: Two types of HE warhead.

REMARKS: Designed for use by infantrymen.

BLOODHOUND



ENTAC

CAISSEUR

FRANCE

R530 (Air Force and Navy)

TYPE: Air-to-air

STATUS: Advanced development

PRIME CONTRACTOR: MATRA

PERFORMANCE: *Range*—10 mi. *Speed*—Mach 1.1

DEPLOYMENT: Intended for the Mirage III and Sud Vautour aircraft

FRAME: *Length*—about 6.5 ft. Has delta cruciform wings with aerodynamic controls like U.S. Falcon

GUIDANCE: Two versions—electromagnetic and IR

BOOSTER: *Type*—Hotchkiss-Brandt solid

SUSTAINER: *Type* — Hotchkiss-Brandt solid

PAYLOAD: *Warhead type*—HE.

AS 30 (Air Force and Navy)

TYPE: Air-to-surface

STATUS: Evaluation trials by NATO

PRIME CONTRACTOR: Nord Aviation

PERFORMANCE: *Range*—almost 9 mi. *Speed*—supersonic

FRAME: *Length*—12.42 ft. *Diameter*—13.8 in. *Span*—3.28 ft. *Total weight*—1100 lbs.

GUIDANCE: Proportional control

BOOSTER: *Type*—solid

SUSTAINER: *Type*—solid

PAYLOAD: *Warhead type*—HE or nuclear

REMARKS: Competitor to the U.S. Bullpup.

AA-20 (Air Force)

TYPE: Air-to-air and air-to-surface

STATUS: Operational

PRIME CONTRACTOR: Nord Aviation

PERFORMANCE: *Range* — 2.5 miles. *Speed*—supersonic.

DEPLOYMENT: *Location*—in hands of Air Force and Navy units.

FRAME: *Length*—8.5 ft. *Launch weight*—(a/a version) 295 lbs. (a/s version) between 295 and 375 lbs.

GUIDANCE: *Type*—radio command.

BOOSTER: *Type*—solid.

SUSTAINER: *Type*—solid.

PAYLOAD: *Warhead type*—HE.

REMARKS: Industrial designation AA 5103 has been adopted for NATO use.

VEGA

TYPE: Surface-to-air
STATUS: R&D
PRIME CONTRACTOR: Nord Aviation.
PERFORMANCE: *Range*—115,000 ft. *Speed*—about Mach 5.
FRAME: *Length*—32.5 ft. *Wingspan* 11.8 ft.
BOOSTER: *Type*—solid.
SUSTAINER: *Type*—ramjet.

ACAM 5301 (Army)

TYPE: Surface-to-air
STATUS: R&D
PRIME CONTRACTOR: Nord Aviation.
PERFORMANCE: *Range*—nearly 10 n. miles. *Speed*—about Mach 2.
DEPLOYMENT: *Location*—to be deployed with Army combat troops, particularly for use against low-flying aircraft.
FRAME: *Length*—14.5 ft. *Wingspan*—about 5 ft. *Launch weight*—1600 lbs.
GUIDANCE: *Type*—radio.
BOOSTER: *Type*—solid.
SUSTAINER: *Type*—solid.
PAYLOAD: *Warhead type*—HE (nearly 90 lbs.)

CAISSEUR (Army)

MILITARY DESIGNATION: SE4200
TYPE: Air-breathing surface-to-surface (tactical)
STATUS: Operational
PRIME CONTRACTOR: Sud-Aviation
PERFORMANCE: *Range*—60 n. miles. *Speed*—Mach .8
DEPLOYMENT: *Location* — French Army combat troops.
FRAME: *Length*—11.5 ft. *Wingspan*—9 ft. 9 in. *Launch weight*—2075 lbs.
GUIDANCE: *Type*—radar command.
BOOSTER: *Type*—solid (2).
SUSTAINER: *Engine*—ramjet.
PAYLOAD: *Warhead type*—HE.
REMARKS: Launched from mobile carrier.

ENTAC (Army)

TYPE: Surface-to-surface (anti-tank)
STATUS: Production
PRIME CONTRACTOR: Nord Aviation
PERFORMANCE: *Range*—about 1 mile. *Speed*—about 180 mph.
DEPLOYMENT: Being purchased by U.S. and Belgian armies.
GUIDANCE: *Type*—wire.
BOOSTER: *Type*—solid.
PAYLOAD: *Warhead type*—HE.
REMARKS: Joint Nord and DEFA development.

MALAFON

MALAFON (Navy)

TYPE: Surface-to-underwater (ASW)
STATUS: To be operational 1962; in service 1963.
PRIME CONTRACTOR: Societe Industrielle d'Aviation Latecoere
PERFORMANCE: *Range* — more than 10 n. miles.
DEPLOYMENT: *Location*—first deployed aboard the 3750-ton ASW Command Ship La Galissoniere.
FRAME: *Type* — rocket-boosted homing torpedo similar to U.S. Navy's Asroc.
GUIDANCE: *Type*—sonar and radio command.
BOOSTER: *Type*—solid.
PAYLOAD: *Warhead type*—HE.

MASALCA (Navy)

TYPE: Air-breathing surface-to-air
STATUS: Nearly operational
PRIME CONTRACTOR: Societe Industrielle d'Aviation Latecoere
PERFORMANCE: *Range*—about 65 n. miles.
DEPLOYMENT: *Location*—aboard French cruisers. *Initially operational*—1960.
FRAME: *Launch weight* — 6000 lbs.
GUIDANCE: *Type*—beam rider.
BOOSTER: *Type*—solid.
SUSTAINER: *Type*—ramjet.
PAYLOAD: *Warhead type*—HE.

MARUCA

MALAFAC (Navy)

TYPE: Surface-to-surface
STATUS: R&D
PRIME CONTRACTOR: Societe Industrielle D'Aviation Latecoere
PERFORMANCE: *Range*—about 25 n. miles.
DEPLOYMENT: *Location*—to be installed aboard French surface warships.
FRAME: *Length*—20.5 ft.
GUIDANCE: Radio command.
BOOSTER: *Type*—solid.
SUSTAINER: *Type*—liquid (acid/furaline).
PAYLOAD: *Warhead type*—HE.
REMARKS: Malafac test missiles have been launched many times at sea.

MARUCA (Navy)

TYPE: Surface-to-air
STATUS: Operational (training)
PRIME CONTRACTOR: Ruelle Naval Arsenal
PERFORMANCE: *Range*—about 10 n. miles.
DEPLOYMENT: *Location* — used aboard French Experimental Missile Ship Ile-D'Oléron (converted transport) for training.
FRAME: *Length*—15 ft. *Wingspan*—5 ft.
GUIDANCE: *Type*—radar command.
BOOSTER: *Type*—solid (4).
SUSTAINER: *Type*—liquid (nitric acid/aniline).
PAYLOAD: *Warhead type*—HE.
REMARKS: Development vehicle for Masurca.

MASURCA (Navy)

TYPE: Surface-to-air
STATUS: Operational
PRIME CONTRACTOR: Ruelle Naval Arsenal
PERFORMANCE: *Range* — 25 n. mi. *Speed*—Mach 1.9
DEPLOYMENT: *Location* — to be installed aboard helicopter carrier Jeanne d'Arc, new pocket cruisers and Surcouf-class squadron escorts over 3000 tons as the French Navy's top air defense weapon. *Initially operational*—1960.
FRAME: *Length*—18.5 ft. *Wingspan*—3 ft. *Launch weight*—3200 lbs.
GUIDANCE: *Type*—radar beam rider.
BOOSTER: *Type*—solid.
SUSTAINER: *Type*—solid.
PAYLOAD: *Warhead type* — HE (220 lbs.)
REMARKS: Masurca I & II advanced models under development.

R-422B3 (Army)

TYPE: Surface-to-air

STATUS: Operational

PRIME CONTRACTOR: MATRA

PERFORMANCE: *Range*—about 60 n. miles. *Speed*—Mach 2.6

DEPLOYMENT: *Location*—metropolitan France. *Initially operational*—1960.

FRAME: *Length*—30.5 ft. *Launch weight*—3500 lbs.

GUIDANCE: *Type* — radar command and homing.

BOOSTER: *Type*—SEPR 732 solid.

SUSTAINER: *Type* — SEPR 706 solid.

PAYLOAD: *Warhead type*—HE (110 lbs.).

REMARKS: R-422B2 is mobile. MATRA R-431, designed to intercept high-altitude supersonic bombers, is under development. R-431 will be powered by a solid booster and a Nord ramjet.

PARCA (Army)

TYPE: Surface-to-air

STATUS: Operational

PRIME CONTRACTOR: DEFA

PERFORMANCE: *Range*—15 miles. *Speed* — supersonic. *Ceiling* — 80,000 ft.

DEPLOYMENT: Used mainly for training.

FRAME: *Length*—18 ft. *Launch weight*—2200 lbs.

GUIDANCE: *System contractor*—C. F. Thomson-Houston. *Type*—radar command.

BOOSTER: *Type*—solid (4).

SUSTAINER: *Type*—solid.

PAYLOAD: *Warhead type*—HE.

REMARKS: Advanced version for use against Mach 3 aircraft under development.

SS-12 (Army)

TYPE: Surface-to-surface and air-to-surface (antitank)

STATUS: R&D

PRIME CONTRACTOR: Nord Aviation

PERFORMANCE: *Range* — more than 4 miles. *Speed*—Mach 1.

DEPLOYMENT: *Location* — to be deployed with French Army combat troops. Also, can be launched from light aircraft and helicopters.

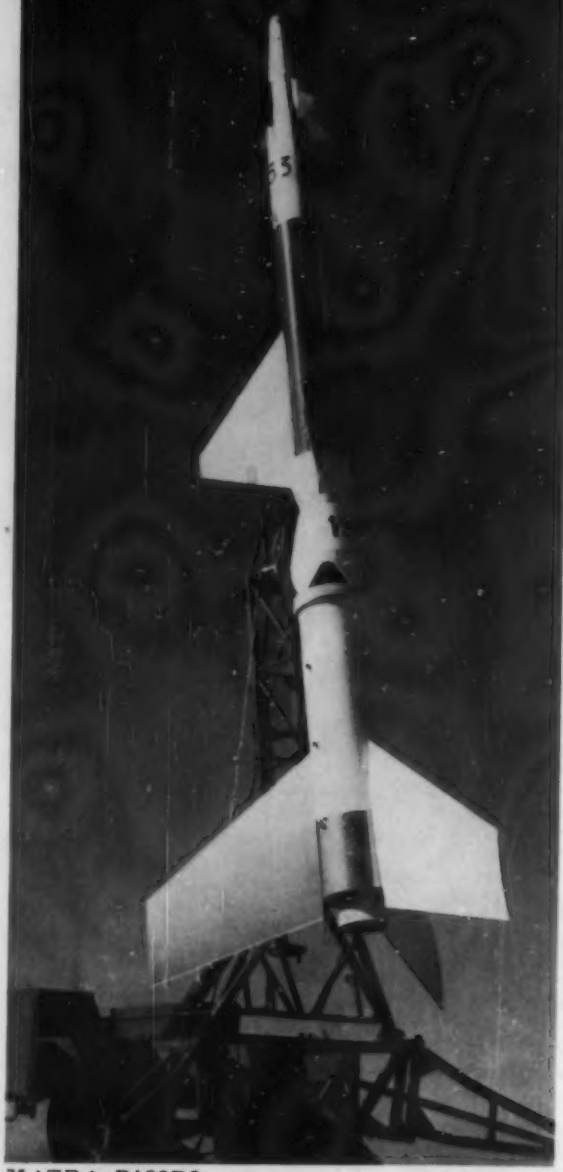
FRAME: *Length* — about 6 ft. *Wingspan*—about 32 in. *Launch weight*—150 lbs.

GUIDANCE: *Type* — wire. Also radar version.

BOOSTER: *Type*—solid.

PAYLOAD: *Warhead type*—nuclear and HE.

REMARKS: SS-12 scheduled to be in production by May, 1961. SS-12 is an advanced version of the Nord SS-10 and SS-11 (See U.S. missiles) which are in the hands of a large number of NATO armies.



MATRA R422B3

PARCA

R-511 (Air Force)

TYPE: Air-to-air

STATUS: Operational

PRIME CONTRACTOR: MATRA

PERFORMANCE: *Range*—about 5 miles. *Speed*—supersonic.

DEPLOYMENT: *Location*—carried aboard French interceptors.

FRAME: *Length*—10 ft. *Diameter*—10 in. *Launch weight*—about 400 lbs.

GUIDANCE: *Type* — electromagnetic semi-passive.

BOOSTER: *System contractor*—Hotchkiss-Brandt. *Type* — solid. *Thrust*—3500 lbs.

SUSTAINER: *System contractor*—Hotchkiss-Brandt. *Type* — solid. *Thrust*—440 lbs.

PAYLOAD: *Warhead type*—HE.

REMARKS: To be replaced by advanced MATRA R-530 about 1962.

SE 4400 (Air Force)

TYPE: Air-breathing surface-to-air.

STATUS: Operational

PRIME CONTRACTOR: Sud-Aviation

PERFORMANCE: *Range*—24.8 n. miles. *Speed*—Mach 3.3. *Ceiling*—130,000 ft.

DEPLOYMENT: *Location*—to be used for French high altitude experiments.

FRAME: *Length*—26.5 ft. *Launch weight*—2640 lbs.

GUIDANCE: *Type*—radar homing.

BOOSTER: *Type*—solid.

SUSTAINER: *Type*—ramjet.

SSBS-1

TYPE: IRBM surface-to-surface

STATUS: R&D

PRIME CONTRACTOR: Societe d'Etude et de Realisation d'Engins Balistiques

PERFORMANCE: *Range*—2300 n. miles.

PAYLOAD: *Warhead type*—nuclear.

JAPAN

TAAM-1D (Air Force)

TYPE: Air-to-air

STATUS: R&D

PRIME CONTRACTOR: Fuji Precision Machinery Co., Ltd.

PERFORMANCE: *Range* — about 1.5 miles. *Speed*—Mach 1.5.

FRAME: *Length*—8 ft. *Launch weight*—335 lbs.

GUIDANCE: *Type*—infrared.

PAYLOAD: *Warhead type*—HE.

TATM-1 (Army)

TYPE: Surface-to-surface (anti-tank)
STATUS: R&D
PRIME CONTRACTOR: Kawasaki Kokuki Kogyu Kabushi-iki Kaisha
FRAME: *Length*—4.5 ft. *Launch weight*—300 lbs.
REMARKS: TATM-2 model also under development. It is 3.2 ft. long.

TLRM-1 (Army)

TYPE: Surface-to-air
STATUS: R&D
PRIME CONTRACTOR: Shin Mitshubishi, Mitshubishi Shipbuilding and Engineering Co.
PERFORMANCE: *Range* — long. *Speed*—about 255 mph.
FRAME: *Length*—10.5 ft. *Launch weight*—about 560 lbs.
GUIDANCE: *Type*—possibly radar.

TMA-1 (Air Force)

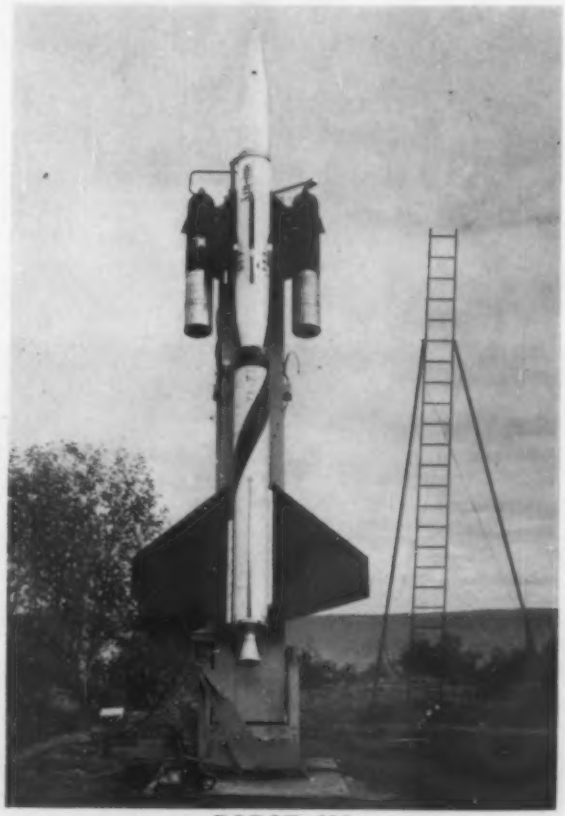
TYPE: Air-to-air
STATUS: R&D
PRIME CONTRACTOR: Shin Mitsubishi and Mitsubishi Electrical.
PERFORMANCE: *Speed* — supersonic.
FRAME: *Length* — about 10 ft. *Launch weight*—more than 200 lbs.
BOOSTER: *System contractor*—Fuji Precision. *Type*—solid.
PAYLOAD: *Warhead type*—HE.
REMARKS: MM-1 is a test vehicle for the TMA-1.

NORWAY

TERNE III (Navy)

TYPE: Ship-to-underwater (ASW)
STATUS: Operational
PRIME CONTRACTOR: Kongsberg Vapenfabrikk
PERFORMANCE: *Range* — more than 3.5 mi.
DEPLOYMENT: Aboard Norwegian Navy vessels; U.S. and other countries are evaluating.
FRAME: *Length*—6.5 ft. *Diameter*—7.9 in. *System design:* Norwegian Defense Research Establishment
GUIDANCE: Contained in attack sonar, fire control and launcher
BOOSTER: *Type*—solid
PAYLOAD: *Type*—HE (105.6 lb. Mk 7 depth charge)
REMARKS: Launcher can fire 6 missiles in 5 secs.

TERNE



ROBOT 322

ITALY

AIRONE (Army)

TYPE: Surface-to-surface (tactical)
STATUS: Operational
PRIME CONTRACTOR: Polverificio Giovanni Stacchini
PERFORMANCE: *Range*—6 miles.
GUIDANCE: *Type*—free.
BOOSTER: *Type*—solid.

C-7 (Air Force)

TYPE: Air-to-air
STATUS: In production
PRIME CONTRACTOR: Societa Italiana Sviluppo Propulsione a Reazione (owned by Fiat and Finmercanica)
PERFORMANCE: *Range*—6 miles. *Speed*—Mach 1.9.
DEPLOYMENT: *Location*—aboard Italian Air Force interceptors.
FRAME: *Length*—6.5 ft. *Wingspan*—25 in. *Diameter*—6 in. *Launch weight*—155 lbs.
GUIDANCE: *Type*—infrared.
BOOSTER: *System contractor*—Thiokol. *Type*—solid.
PAYLOAD: *Warhead type*—HE (55 lbs.)
REMARKS: New models have alternate radar guidance and Bombrini Parodi-Delfino booster.

SWEDEN

ROBOT 322 (Army)

TYPE: Surface-to-air
STATUS: R&D
PRIME CONTRACTOR: Swedish Guided Missile Bureau and Royal Swedish Armed Forces Research Establishment
BOOSTER: *Type*—solid
SUSTAINER: *Type*—twin ramjets

BANTAM (Army)

TYPE: Surface-to-surface (anti-tank)
PRIME CONTRACTOR: A. B. Bofors
STATUS: Operational
PERFORMANCE: *Range*—6500 ft. *Speed*—190 mph.
DEPLOYMENT: *Location* — with Swedish combat troops.
FRAME: *Length*—2.5 ft. *Launch weight*—13 lbs.
GUIDANCE: *Type*—wire.
BOOSTER: *Type*—solid.
SUSTAINER: *Type*—solid.
PAYLOAD: *Warhead type* — HE (3.1 lbs.).
REMARKS: Bantam can be fired from an infantryman's hip.

ROBOT 304 (Air Force)

TYPE: Air-to-surface

STATUS: Operational

PRIME CONTRACTOR: Swedish Guided Weapons Bureau and Royal Swedish Armed Forces Research Establishment.

PERFORMANCE: *Range*—about 3 miles. *Speed*—Mach 1.

DEPLOYMENT: *Location*—Swedish Air Force.

FRAME: *Length*—14.5 ft. *Launch weight*—1000 lbs.

GUIDANCE: *Type*—radio command.

BOOSTER: *Type*—solid.

PAYLOAD: *Warhead type*—HE.

REMARKS: Designed for use against naval targets.

ROBOT 315 (Navy)

TYPE: Surface-to-surface (tactical)

STATUS: Operational

PRIME CONTRACTOR: Swedish Guided Missile Bureau and Royal Swedish Armed Forces Research Establishment

PERFORMANCE: *Range*—10 to 20 n. miles. *Speed*—Mach .9.

DEPLOYMENT: *Location*—aboard Swedish Destroyers Halland and Smaland.

FRAME: *Length*—24 ft. *Launch weight*—3000 lbs.

GUIDANCE: *Type*—not available.

BOOSTER: *Type*—solid (4).

SUSTAINER: *Type*—pulsejet.

PAYLOAD: *Warhead type*—HE.

REMARKS: Torpedoboat model known as Sjorobot.

FRIDA, GERDA (Air Force)

TYPE: Air-to-air

STATUS: Operational on Saab, Lansen and Draken aircraft

PRIME CONTRACTOR: *Armament*—Bofors A.B. *Fire Control*—Saab

PERFORMANCE: Frida has 2624 ft./sec. velocity at 32,000 ft. with .9 sec. burning time. Gerda is an improved version

REMARKS: Adam is an air-to-surface version of the same missile used for strafing. It is about 6 ft. in length, 5 5/16 in. in diameter and weighs 90.4 lbs.—including a 39.7-lb. HE warhead

ERIKA (Navy)

TYPE: Ship to underwater

STATUS: Evaluation

PRIME CONTRACTOR: Bofors A.B.

PERFORMANCE: *Max. range*—more than 1 mi. at 170-ft. depth

FRAME: *Length*—6.7 ft. *Weight*—550 lbs.

PAYLOAD: *Warhead type*—HE (wgt. 220 lbs.)

MOSQUITO

ARGENTINA

A3H (Air Force and Navy)

TYPE: Air-to-surface

STATUS: Operational

PERFORMANCE: *Range* — 3.8 miles.

FRAME: *Length*—about 3 ft. *Diameter* — about 4 in. *Launch weight*—48 lbs. *Material (major)*—steel.

GUIDANCE: *Type*—free.

BOOSTER: *Type*—solid.

PAYLOAD: *Warhead type*—HE.

PAT-1 (Air Force)

TYPE: Air-to-surface

STATUS: R&D

PERFORMANCE: *Range* — about 12 miles.

FRAME: *Length* — about 11 ft. *Diameter*—about 1 ft. *Launch weight*—2310 lbs. *Material (major)*—steel.

BOOSTER: *Type*—liquid. *Propellant*—oxygen and methanol.

PSR-1 (Army)

TYPE: Surface-to-surface (anti-tank)

STATUS: R&D

FRAME: *Length*—3.8 ft. *Launch weight*—19.5 lbs.

BOOSTER: *Type*—Solid (1).

PAYLOAD: *Warhead type*—HE.

REMARKS: Can be launched by one man.

PSR-1

AUSTRALIA

MALKARA (Army)

TYPE: Surface-to-surface (anti-tank). Also effective against bunker fortifications.

STATUS: Operational

PRIME CONTRACTOR: Government Aircraft Factories

PERFORMANCE: *Range*—about 2 miles.

DEPLOYMENT: *Location* — British combat troops.

FRAME: *Length*—6.5 ft. *Wingspan*—2.5 ft. *Launch weight*—206 lbs.

GUIDANCE: *Type*—wire.

BOOSTER: *Type*—solid.

SUSTAINER: *Type*—solid.

PAYLOAD: *Warhead type* — HE (55 lbs.).

SWITZERLAND

RSD-58

TYPE: Surface-to-air

STATUS: Operational

PRIME CONTRACTOR: Contraves AG and Oerlikon Machine Tool Works Buhrle & Co.

PERFORMANCE: *Range* — 18.6 miles. *Speed*—Mach 2.5. *Ceiling*—65,000 ft.

DEPLOYMENT: *Location*—Training units in Italy and Japan.

FRAME: *Length*—20 ft. *Launch weight*—about 900 lbs.

GUIDANCE: *System contractor*—Brown, Boveri & Co. *Type*—beam rider.

BOOSTER: *Type*—liquid.

PAYLOAD: *Warhead type*—HE.

REMARKS: RSA-54 is an earlier model. RSC-57 is a training model. New solid version with improved guidance under development.

MOSQUITO (Army)

TYPE: Surface-to-surface (anti-tank)

STATUS: Operational

PRIME CONTRACTOR: Contraves AG and Oerlikon Machine Tool Works Buhrle & Co.

PERFORMANCE: *Range* — about 6200 ft. *Speed*—200 mph.

DEPLOYMENT: *Location* — Swiss Army units.

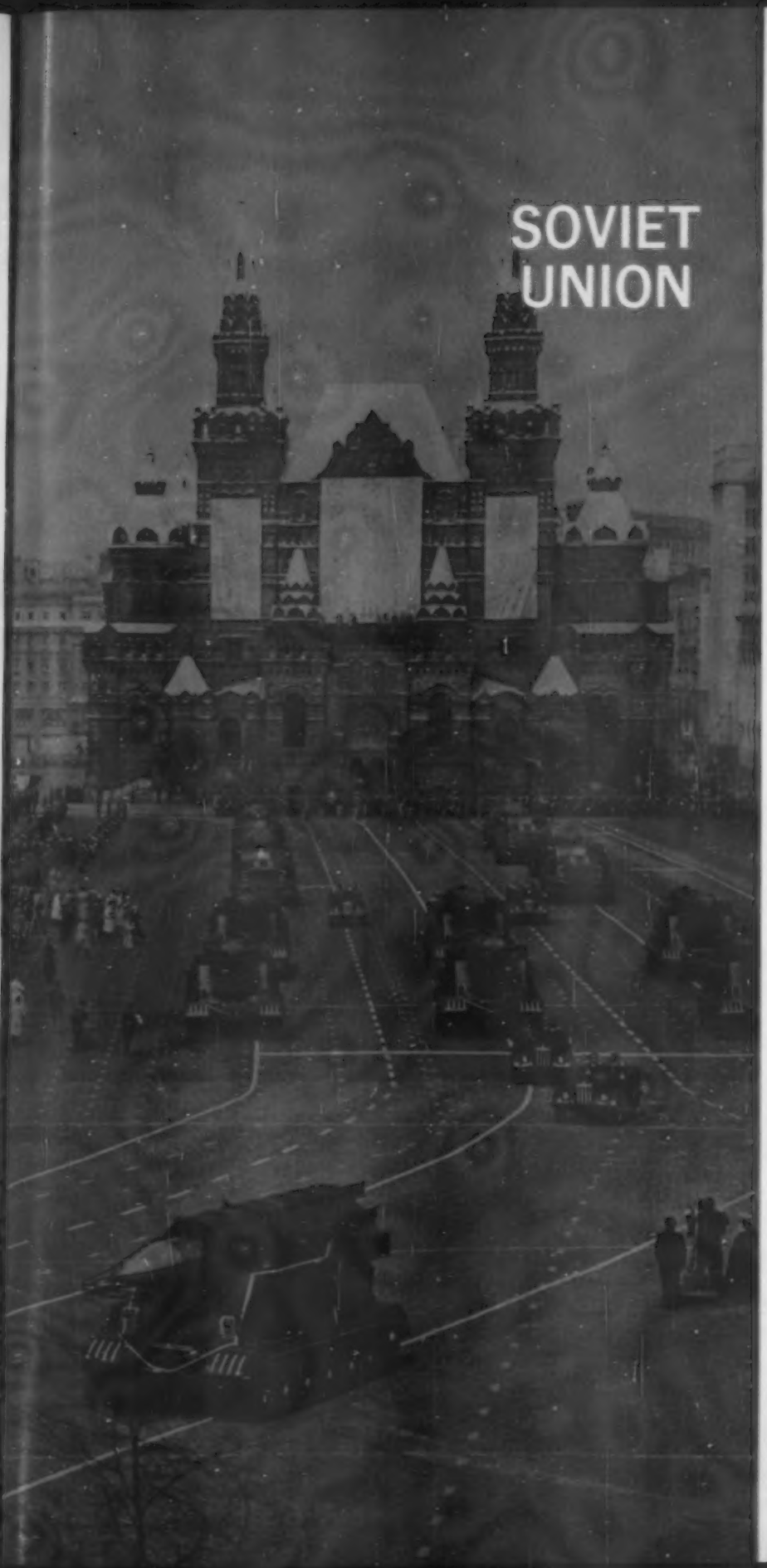
FRAME: *Length* — 3 ft. *Launch weight*—23 lbs.

GUIDANCE: *Type*—wire.

BOOSTER: *Type*—solid.

SUSTAINER: *Type*—solid.

PAYLOAD: *Warhead type*—HE (7 lbs.).



GOLEM 1 (Navy)

TYPE: Surface-to-surface

STATUS: Near operational

PERFORMANCE: *Range* — 400 miles; *Altitude*—125 miles.

FRAME: *Length*—54 ft.; *Weight*—16½ tons gross; single stage.

REMARKS: Developed from German World War II plans for a sea-going V-2 (A-3). Liquid-fueled, radio-inertial guided. Designed to be launched from a capsule towed by a submarine. Nuclear capability.

GOLEM II (Navy)

TYPE: Underwater-to-surface

STATUS: RD&T

PERFORMANCE: *Range* — 1200-1300 miles.

FRAME: *Length*—nearly 60 ft.

REMARKS: Advanced version of the Golem I with improvements adopted from the Army T-2. Probably radio-inertial guided, liquid fueled. Nuclear capability.

GOLEM III (Navy)

TYPE: Underwater-to-air, surface-to-air

STATUS: Operational on surface vessels

PERFORMANCE: *Range*—10 miles.

FRAME: *Length*—15 to 20 ft.; *Diameter*—20 in.

REMARKS: Solid-fueled, infrared-guided. Designed to give both submarines and surface ships anti-aircraft protection.

GOLEM IV (Navy)

TYPE: Surface-to-air

STATUS: Operational on surface vessels

PERFORMANCE: *Range*—45 miles.

REMARKS: A new missile, radar-guided and solid-fueled. May also be converted to submarine use.

J-3 (Navy and Army)

TYPE: Surface-to-surface

STATUS: Operational with the Red Army and at least 7 Baltic fleet cruisers.

PERFORMANCE: *Range*—450-600 miles; *Speed*—supersonic.

FRAME: *Length*—36 ft.

REMARKS: Booster is cluster of 4 solid-fuel rockets; ramjet sustainer. Guidance presumably is beam-riding or programed. Nuclear capability.

T-1 (Army)

TYPE: Surface-to-surface
STATUS: Operational
PERFORMANCE: *Range*—600-775 miles
FRAME: *Length*—50 ft.; *Weight*—19 tons gross; single stage
REMARKS: Mobile IRBM. LOX/hyrocarbon fueled booster generates 77,000 lbs. thrust. Radio-guided. Nuclear capability.

T-2 (Army)

TYPE: Surface-to-surface
STATUS: Operational
PERFORMANCE: *Range* — 1300-1500 miles; *Speed*—5000 m.p.h.
FRAME: *Length*—between 85 and 91 ft.; *Weight*—55 tons; two stages.
REMARKS: Liquid-fueled, 80,000 lb. thrust booster. The T-2 reportedly was the first Soviet rocket used to test an H-bomb warhead. Fired from Central Russia, the warhead was exploded at 120,000 ft. near Bennet Island in the Arctic.

T-3 (Air Force)

TYPE: Surface-to-surface
STATUS: Operational
PERFORMANCE: *Range* — 5000 miles; *Speed*—15,000 m.p.h.; *Apogee*—280 miles.
FRAME: Two stages.
REMARKS: Liquid-fueled with booster developing 500,000 lbs. thrust. Radio-inertial-guided. HE or nuclear warhead. Russia reportedly produced 50 T-3's in 1959 and has capability to build 1200 by the end of 1963.

T-3A (Army)

TYPE: Surface-to-surface ICBM
STATUS: Operational
PERFORMANCE: *Range (Model A)*—6000 miles; *Range (Model B)*—7500 miles; *Speed*—15,000 m.p.h.
FRAME: Model A—2 stages; Model B—3 stages
POWERPLANT: Liquid-fueled. *Model A first stage*—525,000 lbs. of thrust; *Model B first stage*—700,000 lbs. of thrust.
REMARKS: Production of the Model A is believed to have ceased in recent months in favor of the advanced version. Original production plans reportedly called for an equal number of T-3A Model A's and T-3's. The new booster stage on the Model B is believed to be a prototype for one used in the T-4A antipodal missile. Nuclear warhead.

T-4 (Army)

TYPE: Surface-to-surface IRBM
STATUS: Experimental
PERFORMANCE: *Range* — 1000 miles.
POWERPLANT: Two stages, both liquid-fueled.
FRAME: *Length*—53 ft.
REMARKS: 1800-lb. payload may be either nuclear or HE. Some of its configurations are believed to be worked into upper stages of the T-4A.

T-4A (Air Force)

TYPE: Surface-to-surface antipodal missile
STATUS: Advanced RDT&E
PERFORMANCE: *Range* — 10,000 miles; *Apogee* — 186.3 miles; *Speed*—13,660 m.p.h.
FRAME: *Length*—121.02 ft.; *Wing span*—65.6 ft.; *Max. Diameter*—6.88 ft.; *Launch weight*—115 tons.

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POWERPLANT: First stage has 3 LOX/kerosene engines developing 360,000 lbs. thrust.
REMARKS: Catapulted from rail sled. Payload—2350 to 3100 lbs. This is the Soviet counterpart of the U.S. Dyna-Soar boost-glide bomber, stemming from the German Saenger-Bredt design conceived in World War II.

T-5 (Army)

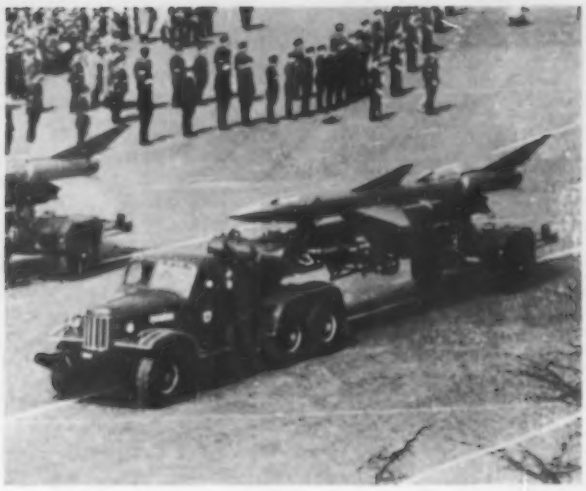
TYPE: Surface-to-surface
STATUS: Operational with Red Army in Eastern Europe
PERFORMANCE: *Range* — 50-100 miles.
FRAME: *Length*—about 36 ft.; 3 stages (advanced version may have 4 stages).
POWERPLANT: Solid-fueled.
REMARKS: Designed for firing from multiple launchers for blitz-type saturation of target. HE or small nuclear warhead.

T-5A (Army)

TYPE: Surface-to-surface IRBM
STATUS: Operational
REMARKS: Few details are available. Believed to be solid-fueled and guided.

T-5B (Army)

TYPE: Surface-to-surface
STATUS: Operational (but out of production)
PERFORMANCE: *Range* — 15-25 miles
FRAME: *Length*—31 ft.; *Diameter*—3 ft.; *Weight*—6000 lbs.
REMARKS: Similar to the U.S. Honest John. Launched from tracked vehicle. Unguided. Carries HE and possibly a nuclear warhead.



T-6 (Army)

TYPE: Surface-to-air

STATUS: Operational

PERFORMANCE: *Range* — 20-25 miles; *Speed*—1500 mph; *Ceiling* —about 60,000 ft.

FRAME: 2 stages

WARHEAD: HE with proximity fuze.

POWERPLANT: Solid fueled with cluster of 4 solid boosters.

REMARKS: Fired from multiple launcher. An advanced version, the T-6A, is radar guided and believed to be operational.

T-7A (Army)

TYPE: Surface-to-surface

STATUS: Operational

PERFORMANCE: *Range*—50 to 90 miles; *Speed*—Mach 5; radio command guidance.

FRAME: *Length*—30 ft.; *Diameter* —2.5 ft.; *Weight*—about 10,000 lbs.

POWERPLANT: Solid fueled

WARHEAD: HE

REMARKS: Has controllable rear fins.

T-8 (Army-Air Force)

TYPE: Surface-to-air (also air-to-air)

STATUS: Operational

PERFORMANCE: *Range*—15 to 25 miles; *Speed*—Mach 2.5

FRAME: *Length*—13 ft.; two stages

POWERPLANT: First stage is cluster of two solid fueled boosters, second stage is liquid fueled.

WARHEAD: HE with proximity fuze.

T-33 (Army)

TYPE: Surface-to-surface ICBM

REMARKS: A new missile. No other details available.

KCAT-25 (Army)

TYPE: Antitank

REMARKS: Never exhibited, believed to be operational.

KOMET I (Navy—CH 17 Army)

TYPE: Surface-to-surface

PERFORMANCE: *Range* — 100 miles; *Speed*—3000 m.p.h.

REMARKS: Solid-fueled, the CH17 is reported to be operational with the Red Army. A crash program is underway to put the Comet I into service aboard submarines and surface ships. HE and nuclear warheads.

KOMET II (Navy—CH 18 Army)

TYPE: Surface-to-surface

PERFORMANCE: *Range* — 600 miles.

REMARKS: Operational with the Red Army and from a surface vessel in calm waters. Crash program in progress with ship motion simulator equipment; R&D for submarines. Solid-fueled, nuclear warhead.

KOMET D (Air Force)

TYPE: Air-to-surface standoff

STATUS: In development and test

PERFORMANCE: *Range*—55 miles.

FRAME: *Length*—33.5 ft.; *Diameter*—about 4 ft.

REMARKS: An equivalent to the British Avro, the turbojet-propelled missile may have beam-riding guidance. Warhead can be either nuclear or HE.

M-2 (Army-Navy)

TYPE: Anti-aircraft

STATUS: Operational with ground defense forces and aboard Baltic Sea cruisers.

PERFORMANCE: *Speed*—Mach 2.

FRAME: *Length*—about 25 ft.; 2 stages.

REMARKS: Solid-fueled. Infrared, radar, or both used as guidance.

M-100A (Air Force)

TYPE: Air-to-air

STATUS: Operational

PERFORMANCE: *Range* — 3½ miles; *Speed*—Mach 2.5

REMARKS: Solid-fueled, semi-active radio-radar command guidance.

ME-IGOR (Army)

TYPE: Antitank

FRAME: *Length*—24 in.; *Diameter* —3 in.

REMARKS: Solid-fueled. Fired from bazooka tube. Was operational, but probably used now only for training.

RS-82, RS-132, RS-132A (Air Force)

TYPE: Air-to-air

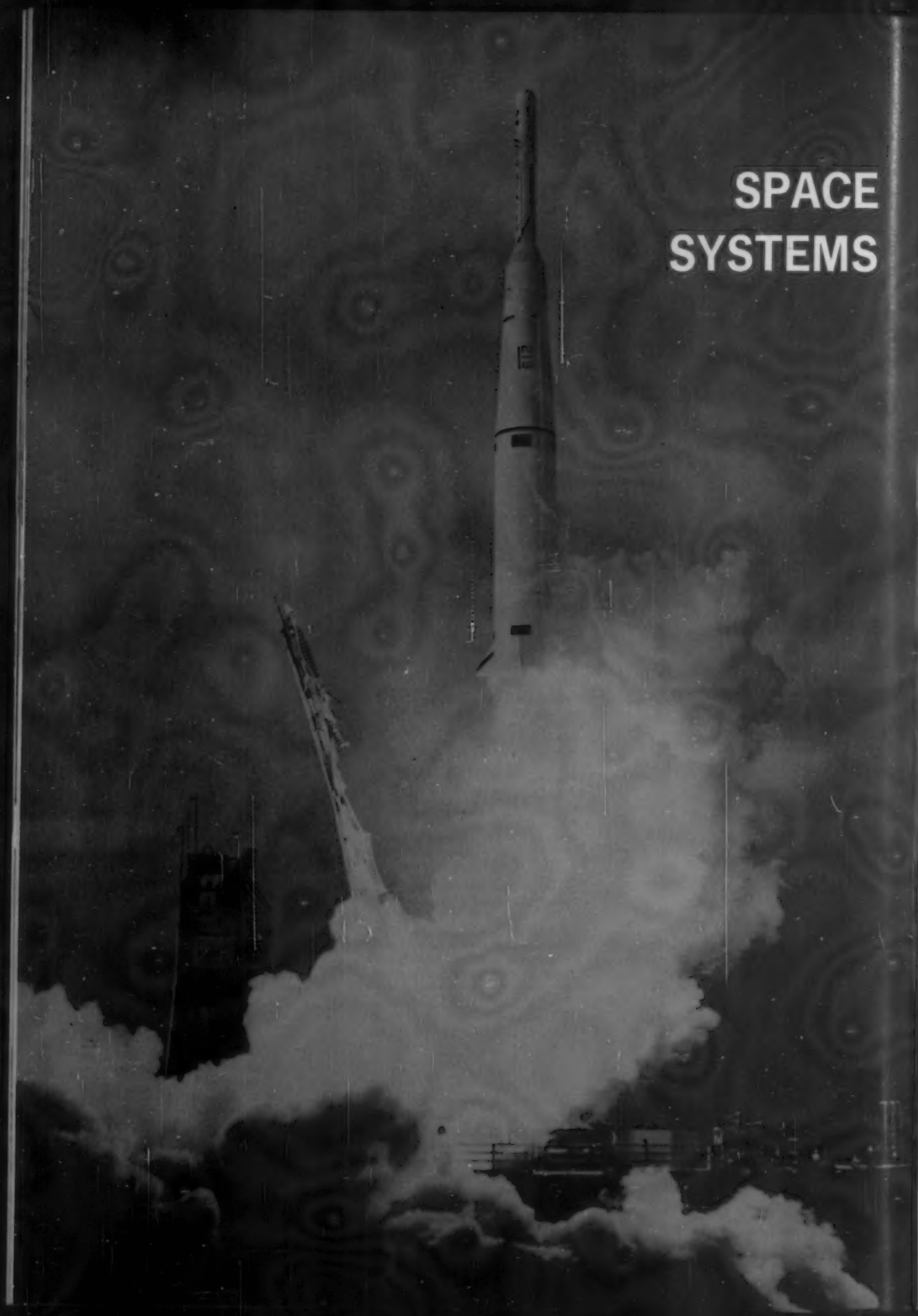
FRAME: *Length*—unavailable; *Diameter*—5.2 in.

REMARKS: Aircraft version of the GVAI. Used for training.

GVAI (Army)

TYPE: Barrage rocket

REMARKS: Multiple-tube launcher, fired in salvoes. May be phased out for more advanced versions.


SPACE
SYSTEMS

A multibillion-dollar U.S. space program is under way in support of the U.S. decision to race Russia to landing a man on the moon.

Military goals in space, however, remained to be clarified. The civilian NASA is handling the lunar mission with Apollo—a follow-on to Mercury. Congress has urged a speed-up in the Air Force's Dyna-Soar, fearing Soviet dominance close to earth following the orbiting of Russian Major Yuri Gagarin on April 12, 1961.

Most difficult hurdle for U.S. is to close the "booster gap."

APOLLO LUNAR LANDING

SPACECRAFT

APOLLO (NASA)

TYPE: Three-man spacecraft

STATUS: R&D

PRIME CONTRACTOR: Convair, General Electric, Martin engaged in feasibility studies.

MISSION: Place manned spacecraft in lunar orbit and return to earth; earth orbiting flights; lunar landings.

FRAME: Ballistic capsule with lifting syrfaces.

BOOSTER: Saturn and/or Nova.

REMARKS: First manned flight scheduled for 1964-65.

DYNA-SOAR (Air Force)

TYPE: Manned boost-glide spacecraft

STATUS: R&D

PRIME CONTRACTOR: Boeing Co.

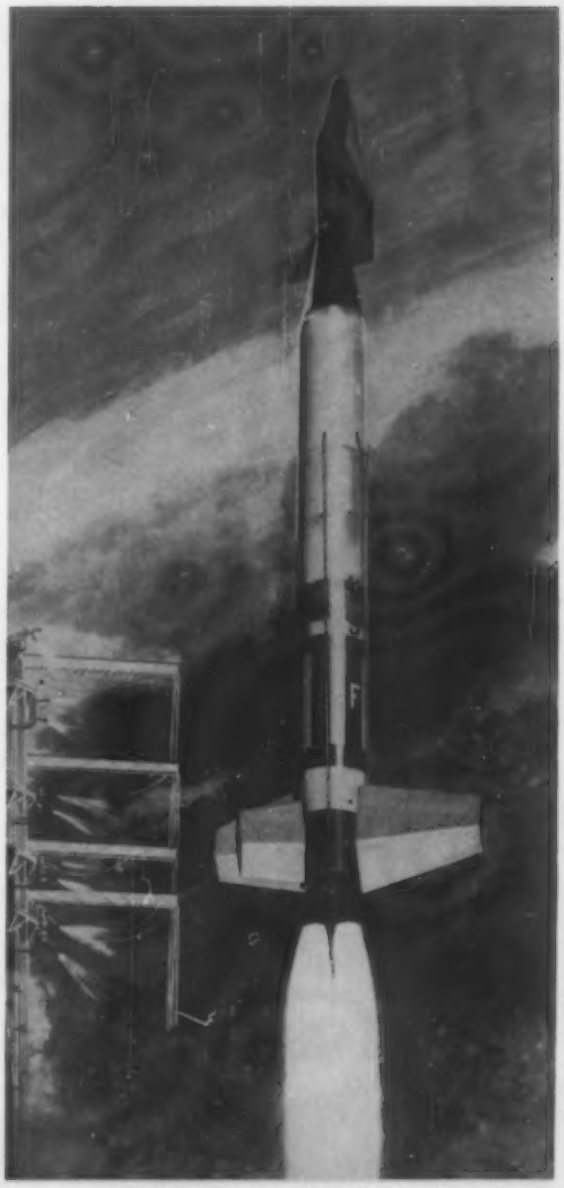
MISSION: Determine feasibility of orbital bomber

FRAME: *System contractor*—Boeing; *System manager*—Aeronautical Systems Div., Air Force Systems Command. *Configuration*—delta-winged glider. *Weight*—about 10,000 lbs. suborbital, up to 20,000 lbs. orbital.

BOOSTER: *System contractor*—Martin. *Type*—modified Titan II for suborbital version; Saturn for orbital.

POWER UNITS: *System contractor for accessory power unit*—Sundstrand Corp. *Type*—gaseous hydrogen-oxygen unit.

REMARKS: The program funded through FY '62 at about $300 million total. Expected to be redirected and accelerated to achieve suborbital flight 1963-64; first orbital flight 1964-65.



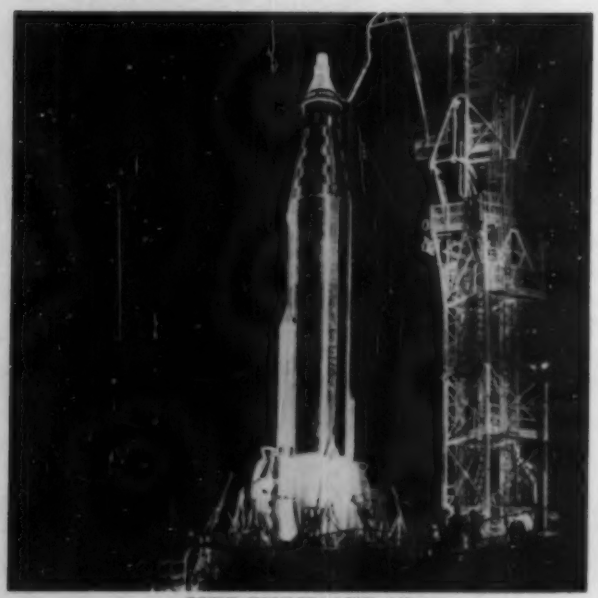
DYNA-SOAR ON TITAN II

←
THOR ABLE IV DEEP SPACE PROBE

X-15

ADVANCED SPACECRAFT

Name	Status	Contractor	Booster	Mission
BOSS (Air Force)	Study	Lockheed, capsule, Garrett Corp., life support system	Atlas-Agena-B	Bioastronautical Orbiting Space Station to provide data on long-term weightlessness, radiation
GSS (Air Force)	Study			Global Surveillance Station
MTSS (Air Force)	Study			Military Test Space Station
SMART (Air Force)	Study			Space Maintenance and Repair Techniques
SLOMAR (Air Force)	Study			Space Logistics, Maintenance and Repair
YO YO (Navy)	R&D	No contract announced		Tactical sea-launched one-pass reconnaissance satelloid



MERCURY-ATLAS

MERCURY (NASA)

TYPE: Manned earth orbiting spacecraft

PRIME CONTRACTOR: McDonnell Aircraft Co.

MISSION: Orbit at about 120 miles altitude. In two flights in 1961 carried chimpanzee "Ham" and astronaut Alan Shepard in sub-orbital flights

FRAME: *System contractor*—McDonnell. *Length*—9.5-ft. *Diameter*—6.5-ft. *Weight*—about 2000-lbs. Total weight of capsule above booster is 4400-lbs.

INSTRUMENTATION: *System contractor*—McDonnell. *Types and functions* — physio-psychological, attitude, navigation.

BOOSTER: *System contractors*—Chrysler, Redstone and Convair, Atlas. *Propellant*—liquid.

POWER UNITS: *System contractor*—McDonnell. *Type*—battery. *Life*—mission plus 12 hours. *Output*—(6) 1500 watt/hour batteries. **REMARKS:** Manned orbital flight scheduled before the end of 1961.

X-15 (Air Force-Navy-NASA)

TYPE: Manned R&D rocket plane

STATUS: R&D flight testing

PRIME CONTRACTOR: North American Aviation, Inc.

MISSION: *Range*—400 n. miles. *Speed*—4000 mph. *Ceiling*—50-100 miles.

FRAME: *System contractor*—North American. *Length*—50-ft. *Launch weight*—31,275-lbs. *Landing weight*—12,971 lbs. *Wingspan*—22 ft.

BOOSTER: *System contractor*—Thiokol. *Propellant* — LOX and liquid ammonia. *Thrust*—57,000 lbs. *Type*—XLR99

POWER UNITS: *System contractor*—General Electric

REMARKS: The X-15 program is aimed at exploration of the atmosphere at the fringes of space.

AEROSPACE PLANE (Air Force)

TYPE: Air-space weapon system

STATUS: Study & R&D

PRIME CONTRACTOR: None

MISSION: Orbital bombing; rendezvous with space stations

REMARKS: ASP would take off from B-52 runway on rocket power and refuel in upper atmosphere by liquefying oxygen for its LOX/LH_2 engine. Air Force estimates that craft could be developed about 1970.

VOYAGER (NASA)

TYPE: Unmanned interplanetary spacecraft

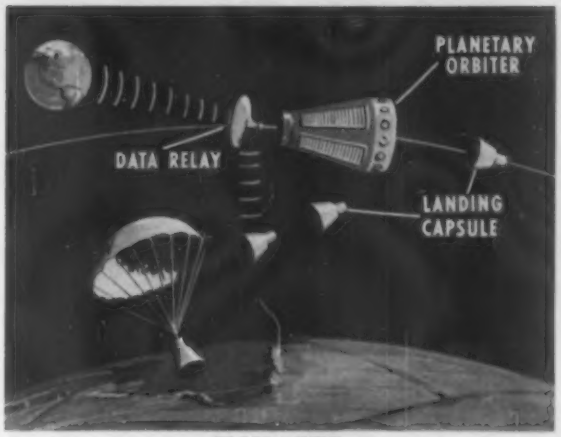
STATUS: Study

PRIME CONTRACTOR: None awarded

MISSION: 2400-lb. spacecraft to orbit Venus and Mars and eject 700-lb. capsule for ground exploration.

BOOSTER: Saturn

REMARKS: First flight planned in 1967



VOYAGER

MARINER (NASA)

TYPE: Interplanetary probe

STATUS: Engineering models under construction

PRIME CONTRACTOR: JPL

MISSION: 600-1200-lb. spacecraft for Venus and Mars flyby exploration

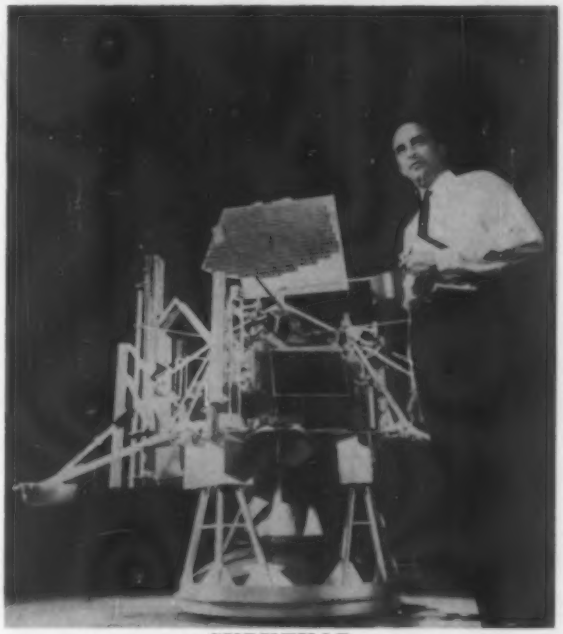
FRAME: Similar to Ranger

INSTRUMENTATION: Radiation and magnetic field experiments, radiometer and spectrometer

BOOSTER: Atlas-Agena B, then Centaur

POWER UNITS: Power supply system will include solar cell panels.

REMARKS: First launch scheduled for August, 1962.



SURVEYOR

PROSPECTOR (NASA)

TYPE: Lunar soft-landing spacecraft

STATUS: R&D

PRIME CONTRACTOR: None announced

MISSION: Land instruments for exploration and mapping of moon. Also possible return of lunar surface samples.

BOOSTER: Saturn

REMARKS: First flights to begin in 1966-70 time period.

SURVEYOR (NASA)

TYPE: Lunar soft-landing spacecraft.

PRIME CONTRACTOR: Hughes Aircraft.

MISSION: Soft land 750-lb. capsule on surface of moon.

INSTRUMENTATION: Capsule will contain 250-lbs. of scientific instruments: Sterox color television cameras, spectrometer, lunar surface drill.

BOOSTER: Atlas-Centaur

POWER UNITS: Power supply will include solar cells

REMARKS: Seven launchings to begin in 1963.

RANGER

RANGER (NASA)

TYPE: Lunar impact spacecraft

STATUS: R&D

PRIME CONTRACTOR: JPL, prime. Aeronutronic, capsule. Hercules, retrorocket.

MISSION: 300-lb. instrumented capsule rough-landed on the moon.

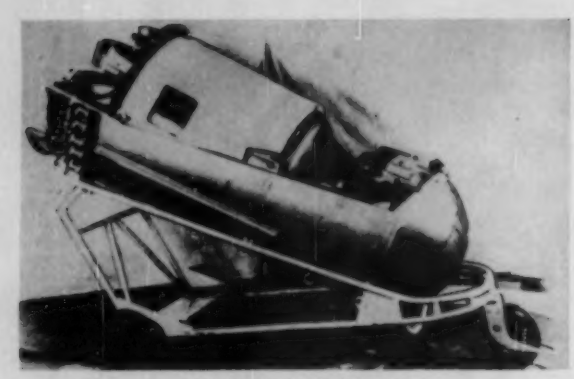
FRAME: Varies with mission.

INSTRUMENTATION: Rubidium vapor magnetometer, Lyman Alpha telescope, Zero db antenna.

BOOSTER: Atlas-Agena B.

POWER UNITS: Solar cells.

REMARKS: Five flights scheduled to begin in 1961. Landing on moon scheduled for 1962.



COSMIC SHIP II

VOSTOK (Russia)

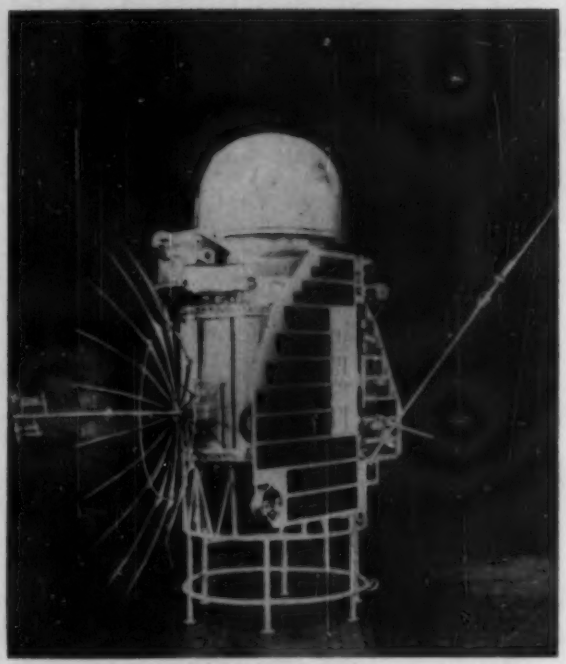
TYPE: One-man spacecraft

MISSION: Orbital space flight

FRAME: Believed to be 20 ft. long. Probably winged. Payload weight 10,418 lbs.

INSTRUMENTATION: Radio and TV equipment relaying data on condition of man aboard; life-support equipment reported capable of sustaining man 10 days.

REMARKS: Launched with Major Yuri Gagarin aboard April 12, 1961 and recovered after one pass around the earth.



VENUS PROBE

SPUTNIKS IX AND X (Russia)

TYPE: Orbital spacecraft

MISSION: Experiments leading to manned space flight. USSR announced successful re-entry and recovery of both capsules. Sputnik IX launched and re-entered Mar. 9, 1961 and Sputnik X launched and reentered Mar. 25, 1961.

INSTRUMENTATION: Radio and TV equipment relaying data on animals aboard.

REMARKS: Cabins recovered in predetermined locations in USSR, with animals reported alive. Sputnik IX said to have carried 13-lb. dog, guinea pigs, black mice, insects and seeds of several plants; Sputnik X, one dog and other animals.

VENUS PROBE (Russia)

STATUS: Lost radio contact several days after launch from orbiting Sputnik VIII. Sputnik down on Feb. 25. Power supplied by chemical sources charged by solar batteries.

MISSION: Orbit sun, flying by or impacting Venus. *Aphelion*—1.0684 astronomical units. *Perihelion*—0.7104 au

FRAME: 80-in. long, 41-in. diameter without antennas and solar paddles, 1419 lbs. Weight of Sputnik not disclosed.

INSTRUMENTATION: Measure cosmic rays, magnetic fields, charged particles of interplanetary gas and corpuscular sunbeams; record micrometeor impacts; temp. control; telemetry; altitude control and stabilization systems.

DEEP SPACE PROBES

Name and Country	Weight (lbs.)	Launch Vehicle	Launch Date	Trajectory and Purpose	Remarks
LUNIK I (MECHTA), RUSSIA	3245	N.A.	1/ 2/59	Escape earth in direction of moon	In 450-day solar orbit; passed within 5000 miles of moon
PIONEER IV, U.S.	13.4	JUNO II	3/ 3/59	Escape earth in direction of moon	In solar orbit of 398 days; passed within 35,000 miles of moon
LUNIK II, RUSSIA	780 (incl. final stage)	N.A.	9/12/59	Lunar impact; radiation and magnetism measurements	Achieved impact
LUNIK III, RUSSIA	About 614	N.A.	10/ 4/59	Earth-moon orbit, apogee 291,000 mi., perigee 30,000 mi., very long lifetime	Took first picture of far side of moon. Not in orbit.
PIONEER V, U.S.	94.8	THOR-ABLE	3/11/60	Solar orbit between Earth and Venus orbits; long-range radio communications; radiation, space environment measurements	Transmitted data more than 20 million miles. No longer transmitting.
VENUS PROBE	1419	Multi-stage	2/12/61	Test methods of injecting probe into interplanetary trajectory; test long-range communications	Probe launched from Sputnik VIII while in orbit

BOOSTERS

CENTAUR (NASA)

TYPE: Multipurpose launch vehicle.

STATUS: R&D

PRIME CONTRACTOR: Convair.

PERFORMANCE: 300-mile orbit—8500 lbs. *Escape velocity*—2500 lbs.

FRAME: *Length overall*—105 ft. *Diameter*—10 ft. *Gross weight*—291,000 lbs. *Major materials*—steel, aluminum.

STAGES: 1. Modified Atlas ICBM. 2. Centaur. *Manufacturer*—Convair; *engines*—Pratt & Whitney LR-115 (2).

GUIDANCE: Minneapolis-Honeywell. *Type*—all-inertial.

REMARKS: First flight 1961. Will provide for the first time U.S. lift capacity equal to Sputnik I and will be most powerful U.S. vehicle until Saturn is available.

CENTAUR

THOR-AGENA (Air Force and NASA)

TYPE: Launch vehicle

STATUS: Operational with Agena A. R&D with Agena B.

PRIME CONTRACTOR: None

PERFORMANCE: *Agena A*—300 lbs. in 300-mile orbit. *Agena B*—1600 lbs. in 300-mile orbit.

FRAME: *Manufacturers*—Douglas, Lockheed. *Length overall*—Agena A 78.6 ft., Agena B 86 ft. *Diameter*—8 ft. *Gross weight*—Agena A 118,500 lbs., Agena B about 123,000 lbs. *Major material*—aluminum

PROPULSION: All liquid.

GUIDANCE: (Only Agena B) Minneapolis-Honeywell. *Type*: All-inertial.

STAGES: 1. Modified Thor IRBM. 2. Agena. *Engine*—Bell XLR-81.

REMARKS: Thor-Agena A in use in Discoverer program. Thor-Agena B, with restartable upper stage, will be used by both Air Force and NASA beginning in 1961.

THOR DELTA, THOR ABLESTAR, THOR AGENA B

TYPE: Launch vehicle

STATUS: All operational.

PRIME CONTRACTOR: Douglas for Delta and for Thor stages in other other two; Aerojet-General for Ablestar vehicle stage and Lockheed for Agena B vehicle stage.

PERFORMANCE: Payload in 300-mile orbit: *Delta*—500 lbs.; *Ablestar*—1000 lbs.; *Agena B*—1400 lbs.

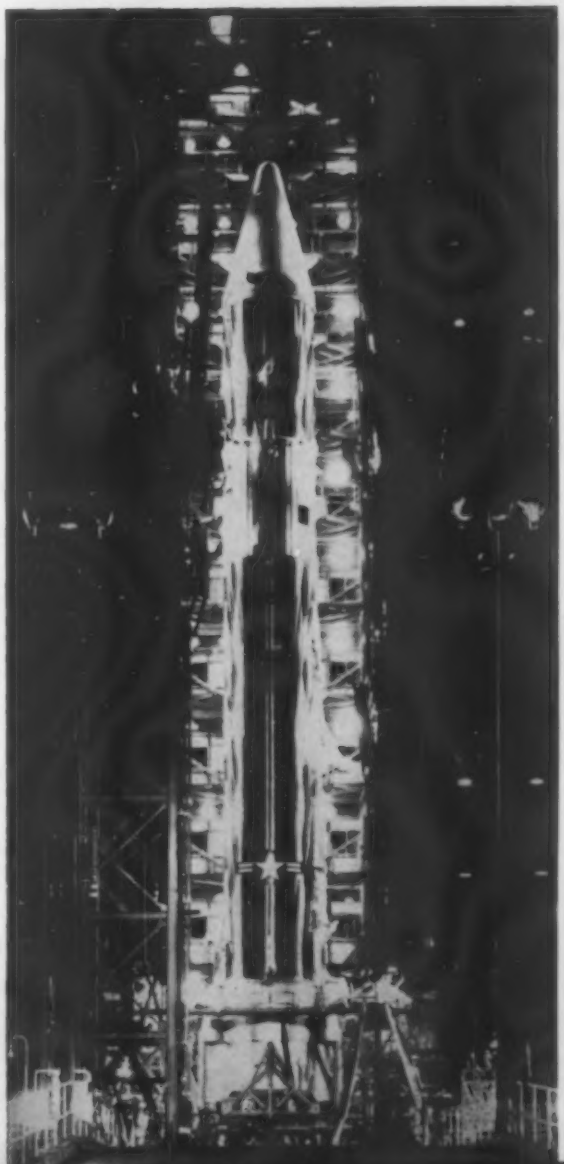
FRAME: *Length overall*—Delta, 92 ft.; Ablestar, 79 ft.; Agena B, 81 ft.; *Diameter*—8 ft.; *Gross Weight*—Delta, 112,000 lbs.; Ablestar, 119,000 lbs.; Agena B, 123,000 lbs. *Major material*—aluminum.

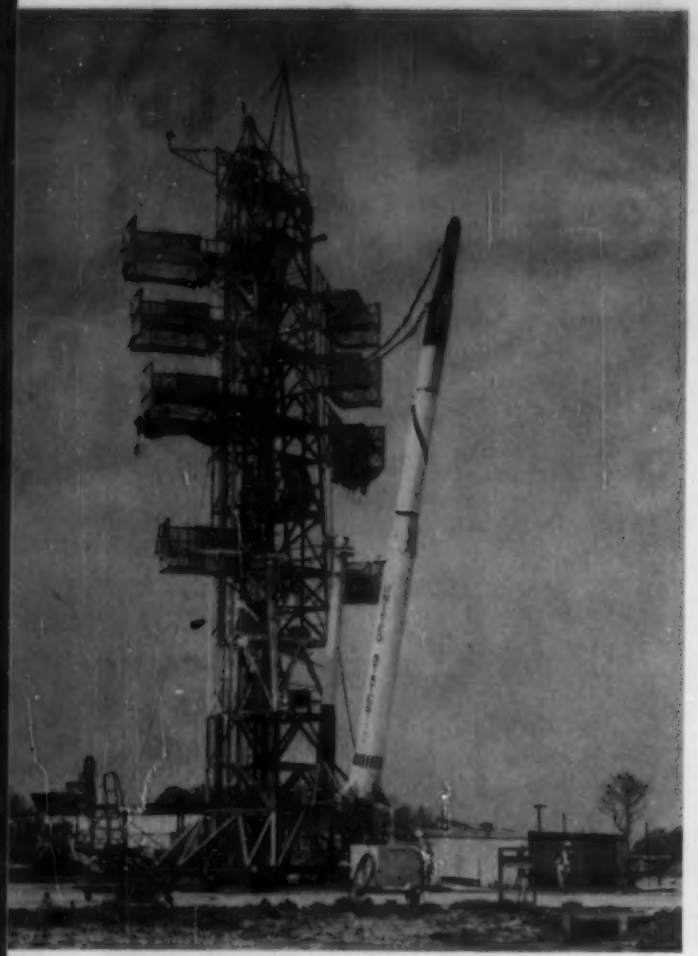
PROPULSION: *Delta*: 2 liquid stages and one solid; *Ablestar and Agena B*, 2 liquid.

GUIDANCE: *Delta*, Bell Telephone; *Type*—radio command; *Thor Agena B*, Bell Telephone (first stage only); *Type*: radio command.

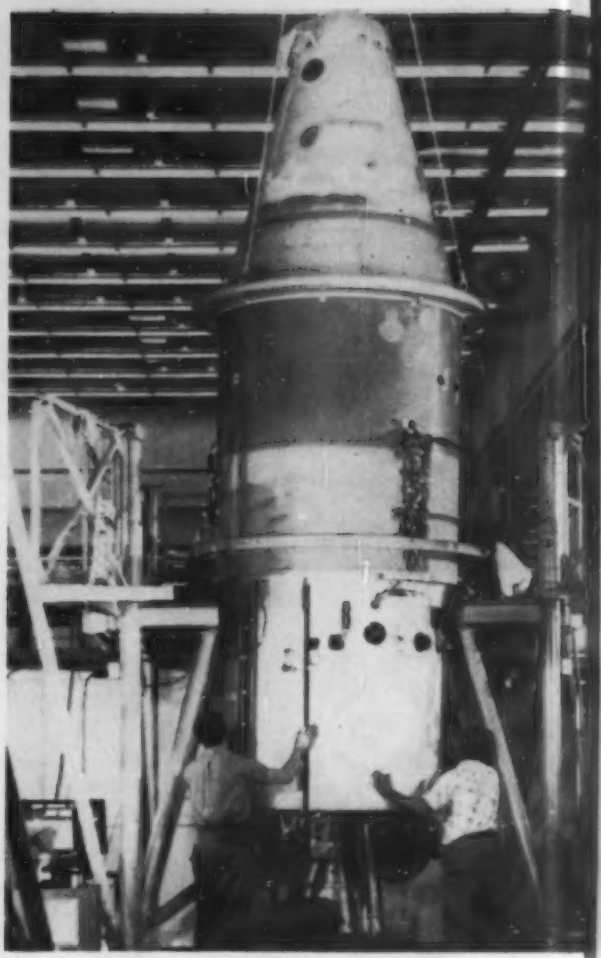
STAGES: 1. Modified Thor IRBM—MB3-1 on Delta; MB3-II—Ablestar and Agena B; 2. AJ-10-118—Ablestar, Agena B; 3. ABL Altair.

REMARKS: Delta has orbited the Echo I sphere, Tiros II and Explorer X satellites for NASA and is scheduled for use in Project Relay and such other NASA scientific satellites as S-3, S-6 and S-16. Its capabilities include a coast period prior to ignition of the third stage. Thor Ablestar, with a restartable, scaled-up Able, is used in the Navy's Transit program and was used for launching of Army's Courier satellites; Thor Agena B is used in the Air Force Discoverer satellite program and will be used in NASA's Nimbus and rigidized Echo satellite projects and for launching NASA polar-orbiting geophysical observatory spacecraft.





SCOUT



AGENA A

SCOUT (NASA)

TYPE: Launch vehicle for small vehicles.

STATUS: R&D

PRIME CONTRACTOR: NASA Langley Research Center

PERFORMANCE: 300-*mile orbit*—about 150 lbs.

FRAME: *Manufacturer* — Chance Vought. *Length overall*—72 ft. *Diameter*—40 in. *Gross weight*—36,100 lbs. *Major materials*—steel and plastic.

PROPULSION: All solid

STAGES: 1. Aerojet Algol; 2. Thiokol Caster; 3. Hercules-ABL Antares; 4. Hercules-ABL Altair.

GUIDANCE: Minneapolis Honeywell. *Type*—semi-inertial.

REMARKS: Air Force has similar vehicle called Hyper-Environmental Test System 609A Blue Scout. Two complete vehicle tests from Wallops Island, Va. One orbit of Explorer IX.

AGENA B (Air Force and NASA)

TYPE: Second-stage launch vehicle

STATUS: Operational

PRIME CONTRACTOR: Lockheed

MISSION: Thor Agena B can launch 1600-lb. spacecraft in low earth orbit. Used as launch vehicle for Air Force Discoverer Program. Atlas Agena B can place 5000 lbs. in low earth orbit or 750 lbs. on trajectory to the moon.

FRAME: *Height*—25 ft. *Diameter*—5 ft. *Weight*—15,550 lbs. with full propellant. Orbital weight—2100 lbs.

STAGES: 1. Thor or Atlas. 2. Agena B—Bell XLR-81, Thrust—15,500 lbs.

REMARKS: Will be used by NASA for a variety of missions and trajectories with first launching scheduled for mid-1961.

TITAN II (Air Force)

TYPE: Medium launch vehicle

STATUS: R&D

CONTRACTOR: *Prime* — Martin; *Guidance*—Aerojet-General.

MISSION: Space booster with thrust of up to 800,000 lbs.

PROPULSION: All Liquid.

GUIDANCE: Inertial.

REMARKS: Should be operational by early 1963. First launch, Nov. 1961. For the Dyna-Soar program, the Air Force plans to add a solid-fuel accelerator escape third stage.

ROVER (NASA-AEC)

TYPE: Nuclear rocket development program.

STATUS: R&D

PERFORMANCE: Super-thrust engines being conducted with Westinghouse and Aerojet for development of NERVA, the first-generation engine. Los Alamos Scientific Laboratory building and testing KIWI nuclear reactor which will be used to develop reactor for engine.

PERFORMANCE: Super-thrust engine to lift very heavy payloads on interplanetary missions.

FRAME: Preliminary design contracts being negotiated with Lockheed, Martin, Convair and Douglas.

PROPELLANT: Liquid hydrogen.

TOTAL WEIGHT: 39,000 lbs.

REACTOR POWER: 1000 megawatts thermal

THRUST (sea level): 52,000 lbs.

PROPULSION TIME: More than five minutes.

REMARKS: Power runs on reactor KIWI-A conducted in 1959 and 1960. Power runs on KIWI-B will be conducted through 1962. Reactor in flight test (RIFT) program will launch first NERVA engine in 1966-1967.

SATURN C-1 (NASA)

STATUS: R&D

PRIME CONTRACTOR: NASA Marshall Center

MISSION: 300-mile orbit—20,000-lbs. *Escape velocity*—5000-lbs.

FRAME: *Length overall (without payload)*—150 ft. *Diameter*—22 ft. *Gross weight*—1 million lbs. *Major material*—aluminum

PROPULSION: All liquid

GUIDANCE: NASA Marshall Center. *Type*—all-inertial

STAGES: S1—Prime, Marshall Center. Engines—8 Rocketdyne H-1. S-2—Prime, Douglas. Engines—6 Pratt & Whitney LR-115

REMARKS: First flight 1961 with dummy upper stages. First two-stage vehicle flight in 1963. Operational 1964.

The Saturn program—which will include C-2 and C-3 vehicles—is the civilian space agency's "main chance" space vehicle in the international space race. The Saturn vehicle in its later forms will be capable of sending a manned spacecraft around the moon. It also will be capable of putting into orbit around the earth multi-ton segments of a space station for assembly in space.

SATURN C-2 (NASA)

STATUS: R&D

PRIME CONTRACTOR: NASA Marshall Center

MISSION: 300-mile orbit—45,000 lbs. *Escape velocity*—15,000 lbs.

PROPULSION: All liquid

GUIDANCE: All inertial

STAGES: S-1 Booster — Prime, NASA Marshall Center. Engines—8 Rocketdyne H-1. S-2 No contractor. Engines—4 Rocketdyne J2. S-4 Prime—Douglas. Engines—6 Pratt & Whitney LR-115. S-5 Prime—Douglas. Engines—2 Pratt & Whitney LR-115.

REMARKS: Under study for Apollo missions

SATURN C-3 (NASA)

STATUS: Study

PRIME CONTRACTOR: NASA Marshall Center

MISSION: 300-mile orbit. Low orbit—50 tons. *Escape velocity*—19 tons

GUIDANCE: All inertial

PROPULSION: All liquid

STAGES: S1 Engines—2 Rocketdyne F-1 (1.5 million lbs. thrust each). S2 Engines—4 J-2. S3 Prime—Douglas. Engine—6 Pratt & Whitney LR-115.

REMARKS: Configuration under study by NASA as a heavy launch vehicle.

NOVA (NASA)

TYPE: Multimillion-lb.-thrust launch vehicle

STATUS: Study

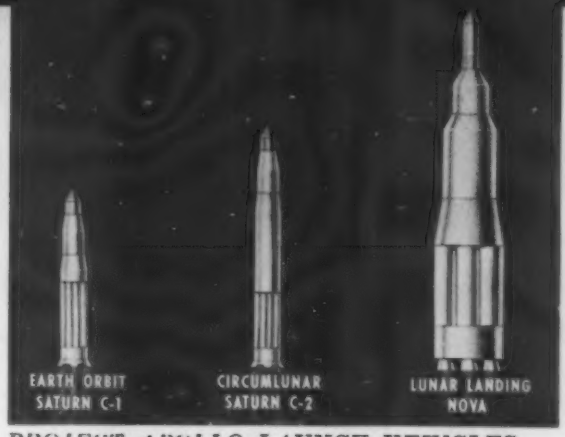
PRIME CONTRACTOR: Not awarded

MISSION: Launch very heavy payloads in earth orbiting and lunar flights

STAGES: 1—8 Rocketdyne F-1 engines; 2—2 Rocketdyne F-1 engines; 3—4 Rocketdyne J-2 engines; 4—6 Pratt & Whitney RL-10 engines; 5—2 Pratt & Whitney RL-10 engines

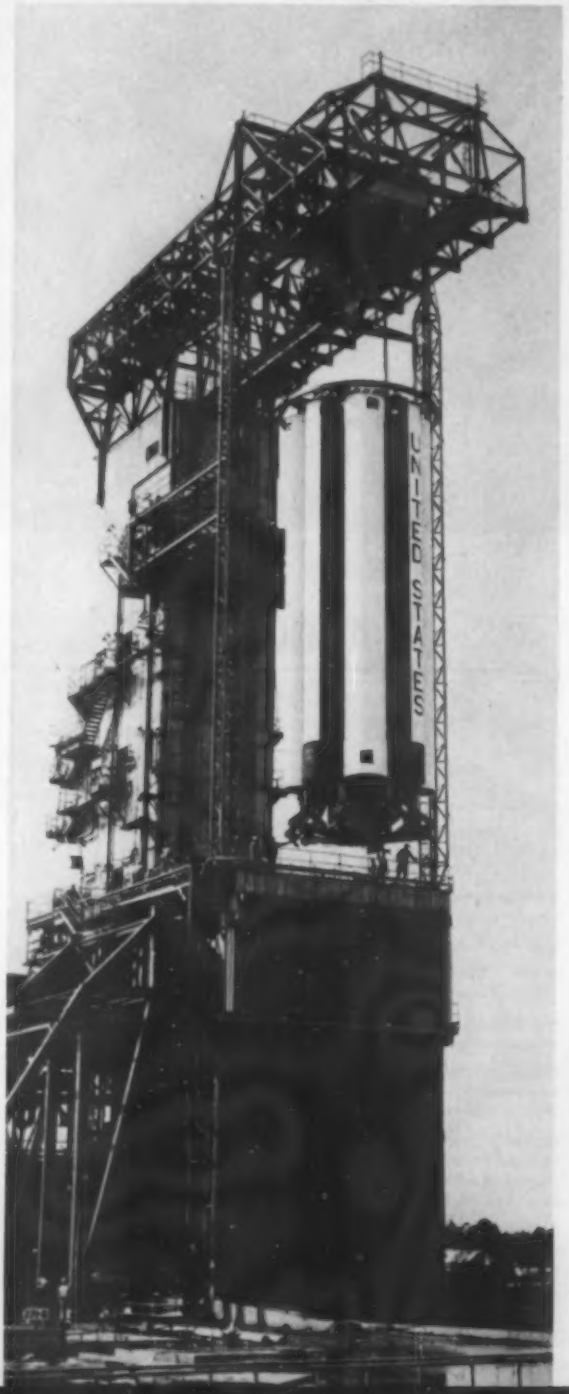
PROPULSION: All liquid in NASA version

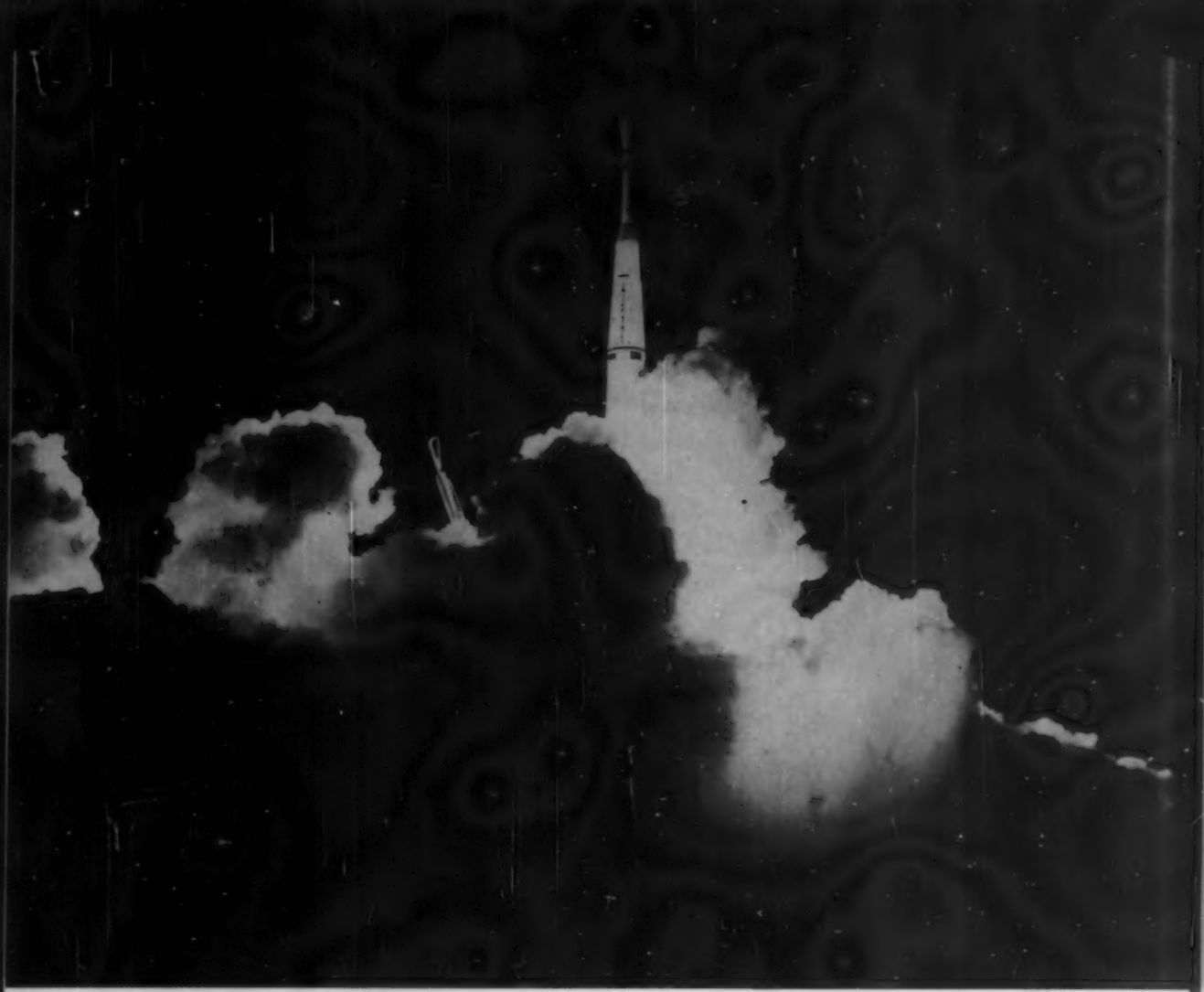
REMARKS: Air Force is developing a 2-3-million-lb.-thrust solid-propellant Nova



PROJECT APOLLO LAUNCH VEHICLES

SATURN BOOSTER





TIROS II

SATELLITES

DISCOVERER (Air Force)

TYPE: Experimental military satellite series

STATUS: R&D

PRIME CONTRACTOR: Lockheed Aircraft Corp.

PERFORMANCE: *Orbit*—elliptical and varied (polar)

FRAME: *System contractor*—Lockheed. *Length*—19.2 ft. *Diameter*—5 ft. *Weight*—about 1700 lbs.

RE-ENTRY VEHICLE: *System contractor*—General Electric. *Type*—capsule. *Length*—27 in. *Diameter*—33 in. *Weight*—about 300 lbs.

INSTRUMENTATION: IR horizon scanner, telemetry, other instrumentation varied.

BOOSTER: *System contractor*—Douglas. *Type*—Thor. *Propellant*—liquid.

SUSTAINER: *System contractor*—Lockheed. *Type*—Agena. *Propellant*—liquid.

REMARKS: The Discoverer program beginning early in 1959 has launched a series of R&D satellites into orbit aimed at stabilization of a satellite in space and recovery of a capsule from orbit. In 25 launchings 5 capsules were recovered. The program calls for eventual recovery of mice and monkeys in the capsule, which would be either air-snatched by planes or picked up by ship. Discoverer is closely tied to the Samos and Midas programs.

MIDAS (Air Force)

TYPE: Early-warning satellite

STATUS: R&D

PRIME CONTRACTOR: Lockheed Aircraft Corp.

PERFORMANCE: *Orbit*—about 300 n. miles; polar.

DEPLOYMENT: *Initially operational*—about 1963. *Number satellites*—more than a half-dozen.

FRAME: *System contractor*—Lockheed. *Height*—22 ft. *Diameter*—5 ft. *Weight*—about 5000 lbs. (operational weight about 3000 lbs.)

INSTRUMENTATION: *Type*—IR scanner designed to detect exhaust flames of a long-range ballistic missile seconds after it is launched; data link telemetry; tape-fed programer.

BOOSTER: *System contractor*—Convair. *Type*—Atlas ICBM. *Propellant*—liquid.

SUSTAINER: *System contractor*—Lockheed. *Type*—Agena. *Propellant*—liquid.

REMARKS: Midas II launched May 24, 1960, into 300/319 mile orbit, but an equipment failure made testing of the IR scanner impossible.

SAMOS (Air Force)

TYPE: Reconnaissance satellite

STATUS: R&D

PRIME CONTRACTOR: Lockheed Aircraft Corp.

PERFORMANCE: *Orbit*—Polar, several hundred miles.

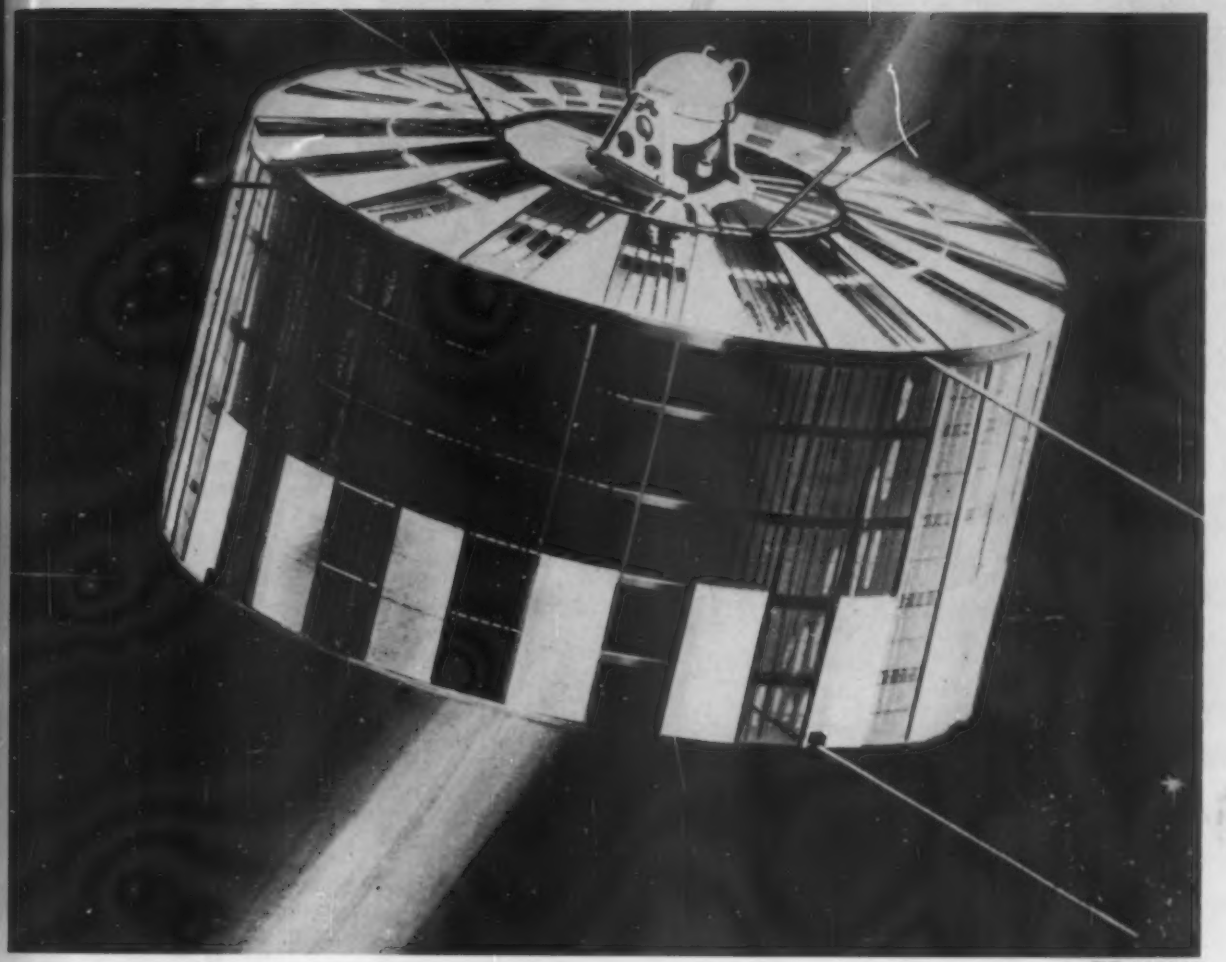
DEPLOYMENT: *Initially operational*—late 1962 or early 1963. *Number of satellites*—less than 6.

INSTRUMENTATION: *System contractor*—Lockheed.

BOOSTER: *System contractor*—Convair. *Type*—Atlas. *Propellant*—liquid.

SUSTAINER: *System contractor*—Lockheed. *Type*—Agena. *Propellant*—liquid.

REMARKS: Samos will provide a continuous reconnaissance of the Earth.



TRANSIT

TRANSIT (Navy-ARPA)

TYPE: Navigation satellite.

STATUS: R&D

PRIME CONTRACTOR: Applied Physics Laboratory.

PERFORMANCE: *Orbit*—about 500 n. miles. (2 polar, 2 equatorial.)

DEPLOYMENT: *Intially operational* mid or late 1962. *Number of satellites*—four.

FRAME: *System contractor*—APL. *Weight*—(Transit-1B) 265 lbs.; (Transit 11A) 223 lbs.; (Transit IVA) 175 lbs. (Operational weight about 50 lbs.)

INSTRUMENTATION: *System contractor*—APL.

BOOSTER: *System Contractor*—Douglas. *Type*—Thor. *Propellant*—liquid.

SUSTAINER: *System contractor*—Aerojet. *Type*—Ablestar. *Propellant*—liquid.

POWER UNITS: Solar cell and storage batteries plus SNAP nuclear generator.

REMARKS: Four R&D satellites have been put in orbit in six tries. All four have operated successfully. The latest—IVA—was launched into a 557/620 mi. orbit June 29, 1961. It carried two piggyback satellites—Injun and GREB III—which separated after orbit injection. Transit will enable surface ships and submarines—particularly Polaris submarines—to fix their position by better than a tenth of a mile.

AEROS (NASA)

TYPE: 24-hour meteorological satellite

STATUS: R & D

PRIME CONTRACTOR: None awarded

MISSION: Stationary equatorial orbit, 22,300-mile altitude

FRAME: Not determined

INSTRUMENTATION: TV cameras for cloud cover; wide area and controllable variable focus

BOOSTERS: Centaur

POWER UNITS: Probably solar cells and batteries

REMARKS: Not officially approved or funded. Fiscal 1962 fund request for development of variable focus type lens and preliminary system studies

TIROS (NASA)

TYPE: Meteorological satellite

STATUS: R & D with experimental operational use being made of TV cloud picture data

PRIME CONTRACTOR: Radio Corporation of America

MISSION: Photographs cloud cover and transmits on ground command

FRAME: *System Contractor*—RCA. *Diameter*—42 inches. *Height*—19 inches. *Weight*—270 lbs., Tiros I; 280 lbs., Tiros II; and 285 lbs., Tiros A3

INSTRUMENTATION: *System Contractor*—RCA. Scanning and non-scanning radiation sensors, narrow- and wide-angle cameras

BOOSTERS: Thor-Delta

POWER UNITS: *System contractor*—Hoffman. Type—solar cells plus nickel-cadmium storage batteries

REMARKS: First launching April, 1960. Second, Nov. 23, 1960. Both successful. Five more planned

NIMBUS (NASA)

TYPE: Meteorological satellite

STATUS: R & D

PRIME CONTRACTOR: NASA

MISSION: 600-mile retrograde quasi-polar 80-degree orbit; earth-stabilized using gas jets and inertial wheels (GE)

FRAME: *System Integration Contractor*—General Electric

INSTRUMENTATION: RCA vidicon cameras for cloud data, radiation sensors at various resolutions and spectral ranges for heat balance, temperature and cloud cover

BOOSTERS: Thor-Agena B

POWER UNITS: Solar cells, paddles and nickel cadmium batteries (RCA)

REMARKS: First launching scheduled for 1962

RELAY (NASA)

STATUS: R&D.

PRIME CONTRACTOR: Radio Corp. of America.

MISSION: Relay wide-band communication signals by a less-than-100-pound satellite. Study radiation effects on components.

FRAME: Not determined.

INSTRUMENTATION: Receiver transmitter, transistors, diodes, vacuum tubes, radiation experiment equipment.

BOOSTERS: Thor Delta.

POWER UNITS: Solar cells and storage batteries.

REMARKS: First launching scheduled for 1962.

ECHO (NASA)

TYPE: Inflated balloon passive communications satellite.

STATUS: R&D.

PRIME CONTRACTOR: NASA.

MISSION: Reflect radio signals off surface of 135-foot sphere.

FRAME: Mylar plastic and aluminum foil laminate, G. T. Schjeldahl Co., and Alcoa; container by Grumman Aircraft Corp.

INSTRUMENTATION: Tracking beacons on sphere.

BOOSTERS: Thor-Agena B.

POWER UNITS: Batteries and solar cells.

REMARKS: To be launched in 1962 in 700-mile circular polar orbit.

REBOUND (NASA)

TYPE: Passive communications satellite using multiple launching of inflated spheres.

PRIME CONTRACTOR: None selected.

MISSION: Reflect radio signal off surface of sphere.

FRAME: Mylar plastic and aluminum foil laminate.

INSTRUMENTATION: None, tracking beacons on sphere.

BOOSTERS: Atlas Agena B.

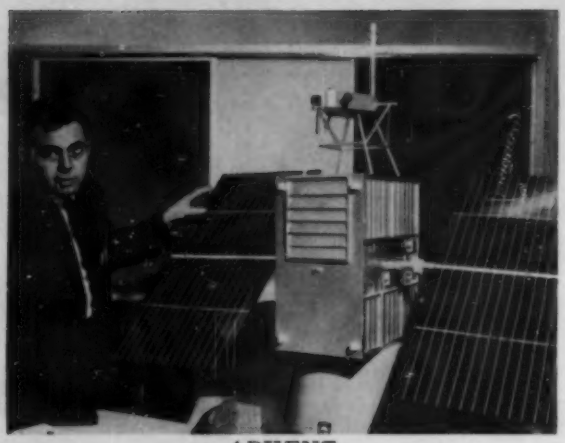
POWER UNITS: Batteries and solar cells.

REMARKS: First launching 1963. Atlas Agena B vehicles to launch three spherical satellites at an altitude of approximately 1700 miles.

ECHO I

SATELLITES IN ORBIT

Name and Country	Weight (lbs.)	Launch Vehicle	Launch Date	Est. Life	Current Apogee & Perigee (mi)	Purpose	Remarks
EXPLORER I, U.S.	30.8	JUPITER C	1/31/58	7–10 yrs.	1120 217	Radiation measurement	Discovered Van Allen belt
VANGUARD I, U.S.	3.25	VANGUARD	3/17/58	200-1000 yrs.	2455; 404	Test VANGUARD concept	Solar battery-powered radio still operating
VANGUARD II, U.S.	20.7	VANGUARD	2/17/59	100-250 yrs.	2052; 343	Test weather-scan concept	
EXPLORER VI, U.S.	142	THOR-ABLE	8/ 7/59	Several months	26,357; 156 (at last report)	Radiation, space envrionment measurements	First "paddlewheel", satellite; position uncertain.
VANGUARD III, U.S.	About 100	VANGUARD	9/18/59	50–150 yrs.	2318; 322	Radiation, space environment measurements	Ended VANGUARD program
EXPLORER VII, U.S.	91.5	JUNO II	10/13/59	30–40 yrs.	669; 344	Radiation, space environment measurements	Still transmitting some data
TIROS I, U.S.	270	THOR-ABLE	4/ 1/60	50-100 yrs.	467; 429	Picture-taking weather satellite	Transmitted 22,952 cloud-cover photos in 78-day instrument lifetime
TRANSIT IB, U.S.	265	THOR-ABLESTAR	4/13/60	6 yrs.	417; 229	First R&D Navigational satellite	ABLESTAR achieved first known restart in space
SPUTNIK IV, Russia	10,008	N. A.	5/15/60	2–3 yrs.	322; 175	Test support systems, cabin for manned flight; attempted return from orbit	Original apogee 229, perigee 188; poor retro orientation spoiled return attempt
MIDAS II, U.S.	5,000	ATLAS-AGENA A	5/24/60	8–15 yrs.	315; 297	IR scanning for early warning of missile launchings	Telemetry failed 5/26/60. AGENA B restarted in space
TRANSIT II-A, U.S.	223	THOR-ABLESTAR	6/22/60	50–200	649; 389.1	Second R&D navigational satellite	Carried "piggyback" for first twin satellite launching. Transmitting.
GREB, U.S.	40	THOR-ABLESTAR	6/22/60	50–200 yrs.	657; 381	Radiation measurements	Passenger aboard TRANSIT II-A
ECHO I, U.S.	132	THOR-DELTA	8/20/60	2–16 yrs.	994; 934	Communications; put 100 ft. inflatable sphere in orbit	First successful orbiting of passive communications satellite
COURIER IB, U.S.	500	THOR-ABLESTAR	10/ 4/60	200–500 yrs.	750; 604	Communications; test feasibility of delay repeater for military	First successful launch of delayed active repeater satellite
EXPLORER VIII, U.S.	90	JUNO II	11/ 3/60	20–50 yrs.	1412; 262	Ionosphere investigation	No longer transmitting
TIROS II, U.S.	280	DELTA	11/23/60	200–500 yrs.	461; 378	Test leading to worldwide meteorological information system	Still transmitting usable data
SAMOS II, U.S.	4100	ATLAS-AGENA	1/31/61		342; 295	Reconnaissance satellite	First R&D model
EXPLORER IX, U.S.	15	SCOUT	2/16/61		1580; 430	Evaluation of SCOUT vehicle and study of atmosphere	12-ft, "polka dot" balloon
DISCOVERER XX, U.S.	2450	THOR-AGENA	2/17/61		444; 176	Evaluation of AGENA B satellite	Orbit achieved. No recovery attempted
DISCOVERER XXI, U.S.	2100	THOR-AGENA	2/18/61		572; 154	IR measurement equipment for MIDAS program	Agena restarted in space for first time
EXPLORER X, U.S.	78	THOR-DELTA	3/25/61		Uncertain	Data on magnetic fields and effect by and on solar plasma	Transmitted data for 60 hrs.
DISCOVERER XXIII, U.S.	2100	THOR-AGENA	4/ 8/61		372; 183	Evaluation of AGENA B satellite	Capsule ejected in wrong direction, sending it farther into space
EXPLORER XI, U.S.	82	JUNO II	4/27/61		1107; 302	Measure gamma rays from the stars absorbed in earth's atmosphere	Vehicle and payload functioned as planned
DISCOVERER XXV, U.S.	2100	THOR-AGENA	6/16/61		250; 139	Systems evaluation of AGENA B	Orbit achieved, capsule recovered.



ADVENT

ADVENT (Army)

TYPE: 24-hour communications satellite

STATUS: R&D

CONTRACTORS: Army Signal Corps., *Prime*—Bendix, prime for 24-hour satellite communications package; GE, vehicle.

MISSION: Place 1250-lb. communications satellite into orbit.

BOOSTERS: Atlas-Centaur, also may use Titan II.

REMARKS: First launching scheduled for late 1962.

COURIER (Army-ARPA)

TYPE: Delayed-repeater communication satellite

STATUS: Operational 1960

PRIME CONTRACTOR: Army Signal Research and Development Laboratories.

PERFORMANCE: *Orbit*—about 650 n. miles. *Operational life*—about 1 year.

FRAME: *System contractor*—Philco Corp. *Diameter*—about 50 in. *Launch weight*—about 475 lbs.

INSTRUMENTATION: *System contractor*—Philco. *Type*—microwave receivers, VHF transmitters.

BOOSTER: *System contractor*—Douglas. *Type*—Thor.

SUSTAINER: *System contractor*—Aerojet. *Type*—Ablestar.

POWER UNITS: *Type*—solar cells (about 20,000); nickel-cadmium batteries.

ECHO

OSO (NASA)

TYPE: Orbiting Solar-Observatory.

PRIME CONTRACTOR: Ball Brothers.

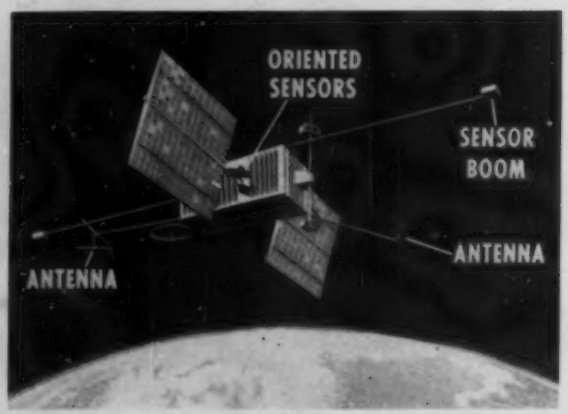
MISSION: Place 350-lb. satellite into orbit for observation of solar radiation.

INSTRUMENTATION: Spectrographs, X-rays, gamma rays.

BOOSTERS: Thor Delta.

POWER UNITS: Solar cells recharging cadmium batteries—78 watts.

REMARKS: First launching scheduled for third quarter 1961.



OGO

OAO (NASA)

TYPE: Orbiting Astronomical Observatory.

STATUS: R&D.

PRIME CONTRACTOR: Grumman (prime), Westinghouse (electric components), General Electric (stabilization and controls).

MISSION: Place 3500-lb. satellite equipped with telescope into orbit.

FRAME: Eight-sided satellite, 9½ ft. high and 6½ ft. in diameter.

INSTRUMENTATION: Will contain 1000 lbs. of experimental equipment, including television tube, telemeter equipment, 24 in. mirror and spectrometer.

BOOSTERS: Atlas Agena B.

POWER UNITS: Solar cells to provide 350 watts.

REMARKS: First flight expected in late 1963 or 1964.

OGO (NASA

TYPE: Orbiting Geophysical Measurement Observatory.

STATUS: R&D.

PRIME CONTRACTOR: Space Technology Laboratories.

MISSION: Place 1000-lb. satellite into orbit with instruments for geophysical measurements. Polar and eccentric shots planned.

FRAME: Satellite will be 6 ft. long by 3 ft. in diameter.

INSTRUMENTATION: Capable of carrying instruments for 50 different geophysical experiments on any one mission.

BOOSTERS: Atlas Agena B, Thor-Agena B, Centaur.

POWER UNITS: Solar cells and storage batteries with 50 watts available for experiments.

REMARKS: First launching expected in 1963.

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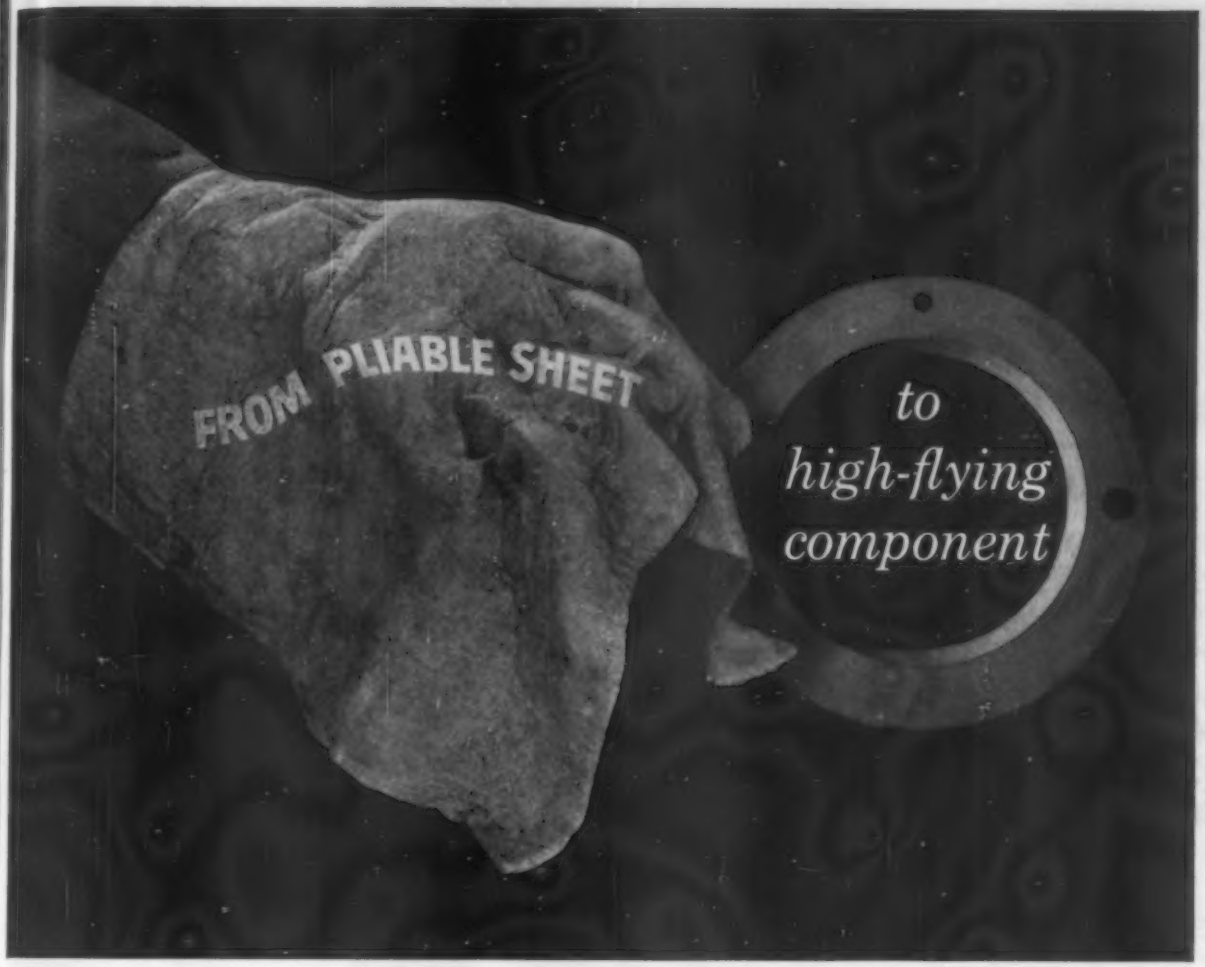

Parts molded of J-M Thermomat® meet the extreme service demands of the missile age

Here is a unique new molding compound in sheet form that offers many advantages in rocket and missile applications. Cured parts and components molded of J-M Thermomat—such as the collar you see here—have already proved they can meet the most extreme service demands.

Because these parts withstand high temperatures, offer maximum resistance to ablation and erosion... they are currently being used as an erosive flame shield for protecting critical guidance and stabilizing mechanisms on operational missiles.

Thermomat's high strength-to-weight ratio is another important advantage, permitting rocket weight to be reduced and fuel capacity increased. Thermomat parts also have a high modulus of elasticity.

In sheet form, this non-woven asbestos-phenolic molding compound is unusually conformable and pliable, making assembly quicker and easier. Molders like the way joints and seams work together as readily as putty . . . and the fact that one man can handle lay-up, saving hours of time.

Non-fillouts are at an absolute minimum, even on complex configurations. Asbestos fibers are free-flowing during molding, resulting in a uniformly reinforced part. This versatile product lends itself to both low and high press molding cycles, thus keeping inventory and waste to a minimum. Any machining of cured Thermomat parts to precision tolerances can be easily accomplished with standard metal-working equipment.

Thermomat is supplied in sheets 14" wide . . . approximately 12' long ...and 1/16" thick. Thermomat in other dimensions may be supplied on request. Molders are invited to write for Technical Bulletin TX-10A and a generous free sample in order to try this remarkable molding material for themselves. Write Johns-Manville, Box 14, New York 16, N.Y. In Canada: Port Credit, Ont.

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Kelsey-Hayes thrust vectoring systems give missiles proper directional control.

Kelsey-Hayes is contributing substantially to the design, development and production of new thrust vector control systems for solid fuel propulsion.

For example Kelsey-Hayes, in a recent crash program, designed and fabricated a movable nozzle control that passed static firing tests for one of the newest sophisticated missile systems.

The swivel nozzle control is just one of the latest developments by Kelsey-Hayes as a subcontractor of propulsion subsystems, flight componentry and high performance materials. Spearheading Kelsey-Hayes activities is the Advanced Design Group, a flexible team of experienced design specialists. Kelsey-Hayes Company, Detroit 32, Michigan.

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Technical Countdown

ELECTRONICS

ESG Research Nears Fruition

Minneapolis-Honeywell's electrostatic gyro development effort is snowballing. Funding to date is reportedly well over $8 million. The project was begun in 1956 under a Navy contract; it was later decided to employ the gyro in an advanced *Polaris* IRBM guidance system. The Air Force is now partially funding the program. Since January, 1961, test units have accumulated over 6000 hours operating time. One Honeywell ESG has been operated continuously for over 2000 hours.

Saturn Guidance Selected

Marshall Space Flight Center has selected the *Centaur* guidance platform, with modifications, for use in early *Saturn* flight vehicles. (TECHNICAL COUNTDOWN reported last week that Librascope had been chosen to provide the guidance computer.) The modified *Centaur* inertial system and test equipment will be developed by Minneapolis-Honeywell under a $1.134-million contract. (Note: Five *Centaur* guidance systems have been delivered to date to Convair by Honeywell.)

Miniaturizing by Necessity

Computer experts have reached an impasse, according to one National Bureau of Standards scientist, which can be resolved only by miniaturizing future computers. The main limitation in faster response time, it seems, is the distance between computer elements. Miniaturization can reduce this transit time. Also being discussed is use of the transistor's active element for transmission paths—to reduce even further the time required for information to get from one place to another.

Control Data for Space Vehicles Determined

A study done for the Air Force by Bell Aerosystems Co. has determined that the data most essential for the control of high-altitude and space vehicles were primarily velocity, attitude, density altitude—and the rates of change of these quantities, when available.

Synthetic Eye Conceived for Guidance

Based on a long-term study of the human visual system, General Electric's Advanced Electronics Center in Ithaca has conceived a bionics machine for potential use in spacecraft terminal guidance. Called Visilog, the design calls for a synthetic eye capable of perceiving two-dimensionally, measuring and processing information. Such a system, says G.E., would be capable of both performing slant estimation (for depth) and obtaining an impression of closing distances.

New Memory Device Introduced

A new thin-wall cylindrical film memory device with outputs for "one" and "zero" range to several hundred millivolts has been produced by CBS Laboratories. Film thicknesses of 30,000 Angstroms have been achieved for rotational switching, as compared with thicknesses of 1000-4000 Angstroms obtained with planar dots.

Vertical Sensing Element Revealed

A gravity-sensitive, liquid-damped pendulum—capable of electromagnetic vertical sensing—has been introduced by Kearfott. A jewel-suspended permeable mass acts as the variable reluctance for two orthogonally-mounted differential transformers in order to provide a phase-sensitive output signal proportional to the tilt angle.

OPTICS

Optics in Space to be Studied

What happens to optical instrumentation in space will be studied in an 18-month contract newly awarded by the Air Force to ITEK Laboratories. Principal goal in the million-dollar task is to develop criteria for future development of optical systems to assure their survival in the space environment without undue degradation. Study will look at all factors including temperature change, launching shock, vibration, and high-energy radiation. ITEK approach will be to test a typical high-performance optical system in simulated environments in its laboratories.

ASW & SEABORNE SYSTEMS

Celestial Navigation Proposed for Subs

A modified aircraft celestial star tracker mounted on top of a submarine periscope can substantially improve the ship's navigation capabilities, a Kollsman Industries spokesman feels. A semiautomatic, photoelectric sextant—basically a modified version of a system used on the B-57—would automatically track a star or other celestial body for position fixing. The system would also compensate for both hull rocking and periscope bending.

Surface SINS Serves Successfully

The N7C marine inertial navigation system built for the Air Force by Autonetics has been operated successfully for over 3000 hours without failure, the NAA division says. Used aboard the USS Twin Falls Victory, new tracking vessel on the Atlantic Missile Range, the system is similar to the SINS system used to guide *Polaris*-carrying submarines.

New Sub Steering Tested

Submarine piloting may soon be as simple as steering a car down a super-highway. Aboard the nuclear attack submarine Shark, the Navy has been conducting experimental tests—so far successful—of a system known as CONALOG, for "contact analog." The new system displays on a screen tube a "highway" with a "floor" and a "ceiling" which simulate the proper course and the bottom and surface of the ocean. Changes in course put the submarine "on" or "off" the road. Inputs are desired course, speed and depth into a display generator.

SUPPORT EQUIPMENT

Will Computers Replace Managers?

PERT's current extension into cost and reliability is being watched with high interest in the Defense Department and may be harbinger of PERTing entire weapons and space systems (see p. 110). Ultimate PERT is being seen as one in which resources and weapons systems objectives are cranked into a computer which in turn puts out the proper mix of money, time utilization and system performance.

PERT's Horizon Beginning to Widen

Proven in Polaris program, concept which now includes cost measurement may be used on full weapon/space

by William Beller

THE NAVY'S computerized management tool—PERT (Program Evaluation and Review Technique)—is being extended to measure systems cost and reliability.

The Defense Department, moreover, is reported considering expanding the scope of PERT to the analysis of entire weapons and space systems.

Backing for PERT-type analysis—the method used so effectively to help telescope the *Polaris* R&D timetable and which the Army and Air Force have started to use in major systems development—is already apparent in high places.

Charles J. Hitch, former RAND economist, is known to favor a better accounting of weapons systems costs, from concept to deployment. In his book, "Economics of Defense in the Nuclear Age," which has become quite popular since his appointment as Defense Department comptroller, he says:

"Efficient techniques and policies have to be selected consciously; and wherever the relevant factors are diverse and complex as they frequently are, unaided intuition is incapable of weighing them and making an efficient decision."

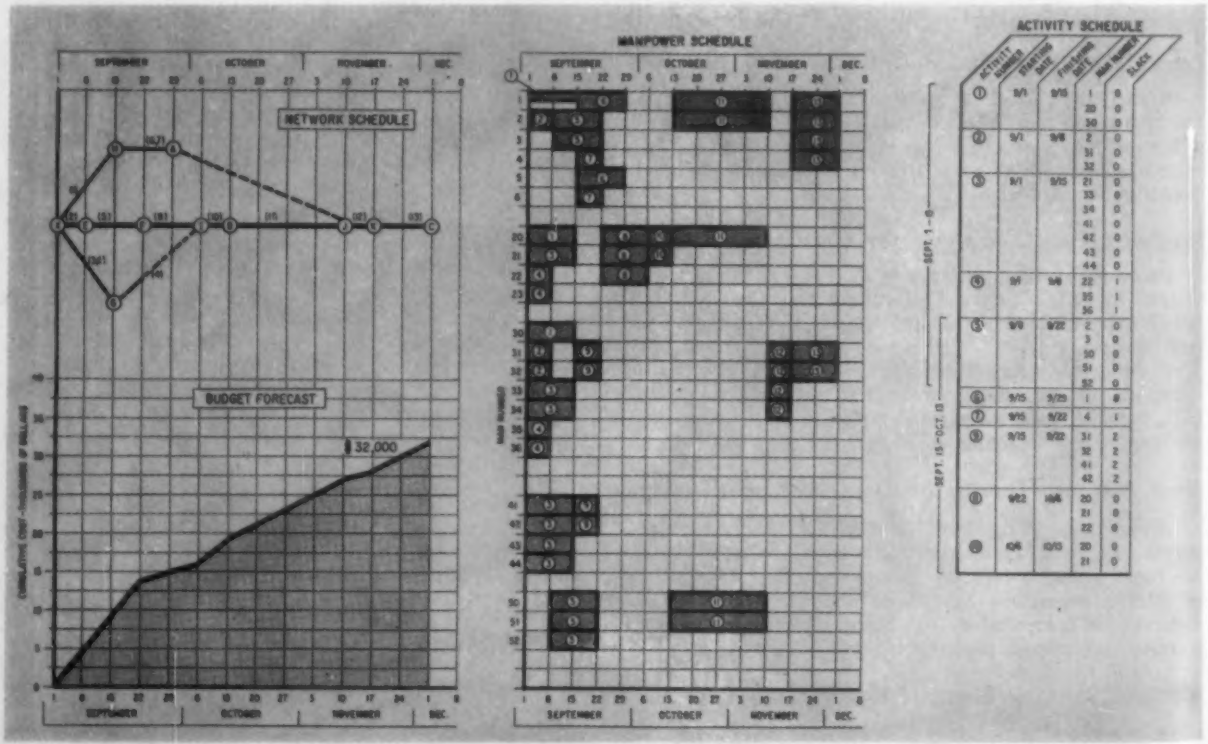
• **Time is the measure**—The original PERT as it emerged out of the Navy's Special Projects Office was developed by an industry-military team to get complex jobs done on schedule. "Time" was used as the independent variable and PERT gave managers the equation by which they could plan, schedule and control the effects on time of R&D procedures and industrial performance. This use is now known as "PERT-TIME."

Then early this year, the Special Projects Office set up an operations research team to inject "cost" into PERT. The intent is to plan, measure and control dollar costs and physical resources through PERT logic. The work has already advanced to data collection for a feasibility test on a *Polaris* component.

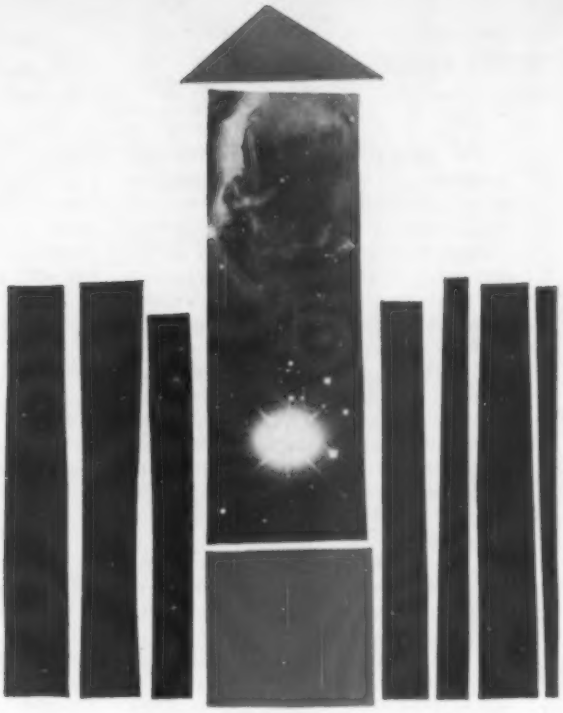
The Office is also developing another major offshoot of PERT-TIME for monitoring, predicting and controlling weapon and space system reliability. Code-named PRISM—Program Reliability Information System for Management—the new concept is already being pilot-tested, in part, by monitoring contractor and customer compliance with reliability requirements during development of the A-3 *Polaris* system.

• **Return on principal**—Many management dividends are seen accruing to organizations investing even a small amount of time and effort in PERTing costs. Among these are:

(Continued on page 113)



PERT-COST OUTPUTS include continuous budget forecasts and manpower loadings.



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Possible RecordTemp Range Set in Solid Tests

Grand Central's new solid undamaged after tests from —120 to 220°F—big-booster evaluation firing imminent

A SIGNIFICANT STEP toward production of space rocket motors has been achieved by Grand Central Rocket Co., following tests of a new solid propellant over what is believed to be the widest temperature range ever achieved.

More than thirty test-firings without failure have been made on a nominal 4000-lb.-thrust test motor from —100 to 180°F at Grand Central's Beaumont Proving Grounds. The GCR-developed solid propellant also passed the more severe temperature-cycling test from —120 to 220°F without damage to the case liner or the grain, said Albert T. Camp, Assistant Vice President and Chief Staff Scientist.

The GCR-supported program for the development and selection of a solid propellant for the big boosters, Camp explained, required a full evaluation of the factors of propellant performance, ignition characteristics, physical properties, processibility, cost and availability of ingredients, resistance to deterioration upon aging, safety from detonation and combustion stability.

Before a specific propellant composition was chosen, the company conducted one of the most thorough analytical and experimental studies ever undertaken to determine the exact propellant properties required for the Air Force big-booster motor design. The new propellant was then tailored to fully meet all these requirements. A GCR production igniter was used for each test with no hangfire or other evidence of low-temperature problems.

The new propellant is known as Polycarbutene-R, Camp said. It is made from a production-type liquid polymer of butadiene and acrylic acid, which has been available in large volumes for less than 3½ years. Aluminum powder is added to the mixture at a typical percentage, exact numbers being retained as proprietory information.

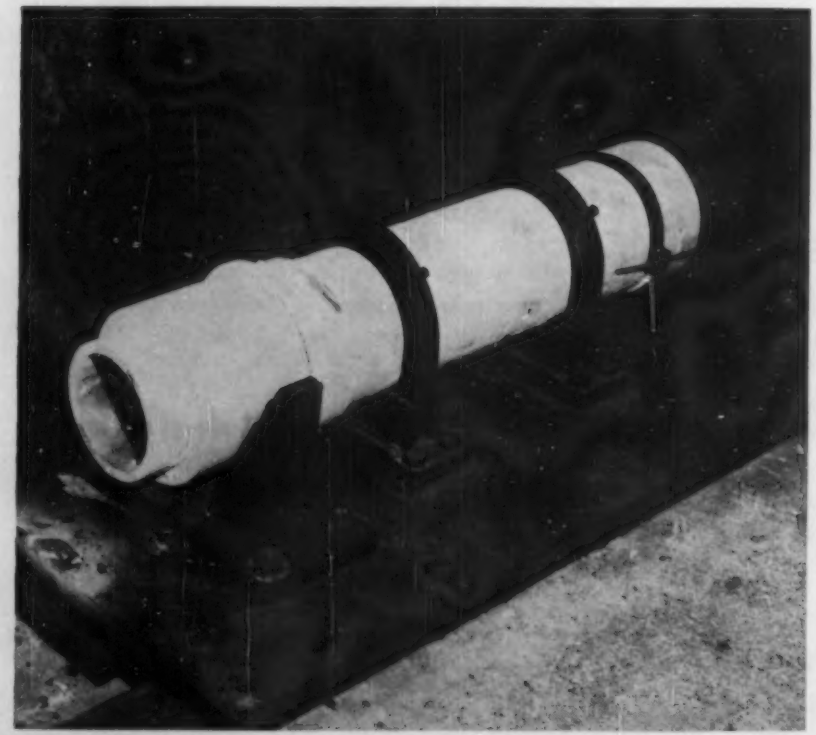
Grand Central attributes its success in developing the space propellant to use of advanced types of curing agents, available only in the past year to solid-propellant processors. When the polymer is combined with the new curing agent (of which even the name is still classified), the curing process can be accomplished faster and at lower-than-normal temperatures, explained Camp. He describes modern curing agents as the "handles" for the curing reactions.

The development of the liner used to bond the cast propellant charge to the motor case was equally important, and as difficult a task as the propellant work. "Here the problem is to develop a material that is highly cohesive and extremely adhesive to propellant and hard surfaces alike," Camp noted. The properties of the liner material are slightly different from those of the grain. GCR chemists found that a polymer of butadiene acrylonitrile and acrylic acid made it possible to qualify the liner system in laboratory and firing tests from —110 to 220°F.

Grand Central Rocket plans to test-fire two subscale, three-foot-diameter segmented motors this summer containing more than 5000 lbs. of the new propellant each to determine how the compound will perform in the multi-ton units planned for the nation's big-booster program.

The tests will be supplemented by the test-firing of two larger motors, also at the Beaumont facility, containing approximately 8000 lbs. of the Polycarbutene-R. The test-firings will be conducted on units conditioned over a wide range of temperatures.

"This is the propellant," said Camp, "which Grand Central Rocket is proposing for the big rockets to be developed for the lunar landing and space probe programs because it provides superb physical properties over a wide range of temperatures under all conditions of service."



FRIGID MOTOR—Fifty-lb. motor shown here is heavily coated with frost from its —50°F temperature as it is ready for test-firing at Grand Central.

(Continued from page 110)

—The ability to see the effects on costs of different mixes of tasks, times and specifications.

—A basis for finding the set of resources that will use a task's R&D dollars and time available to best advantage.

—A means for anticipating and assessing trouble spots.

—A technique for showing alternate paths that can be taken and their costs.

—A method for improving corporate control of costs and time.

—Perhaps most valuable of all, a way to give management relevant cost information quickly, accurately and on an exception basis.

It may be remembered that the PERT-TIME analysis of an R&D task gives to management in a highly readable form—the PERT network—a constantly current report on (1) the bottlenecks that can be expected, that is, the "critical paths"; and (2) the associated activities that can be done with time to spare, that is, the "slack paths." From these data, management can anticipate scheduling problems and make appropriate decisions.

Thus PERT-TIME suffices for a crash R&D program where money and assured reliability are subordinate to time.

But for the more familiar types of R&D tasks, where costs and reliability play parts equally as important as schedules, the outputs from a PERT-COST analysis are needed. These can include:

—Expected project direct costs by skill, month and department.

—Expected manpower requirements by skill, month and department.

—Individual man loading by month.

RELIABILITY MATURITY INDEX (RMI)

INERTIAL GUIDANCE SYSTEM

As of Date _____

ITEM (COMPONENT AND SUBCOMPONENT)	COMPLIANCE RATING FACTORS	RELIABILITY ACTIVITIES										COMPOSITE	
		DESIGN SPECIFICATION	ENGINEERING TEST SPECIFICATION	ENVIRONMENTAL TEST PLAN	FLIGHT TEST PLAN	RELIABILITY TEST SPECIFICATIONS	QUALITY INSPECTION TEST REPORT	RELIABILITY EVALUATION	REPAIR AND MAINTENANCE MANUAL	RELIABILITY TEST EVALUATION		ACTUAL	PLAN
GIMBAL PLATFORM	SCHEDULE												
	QUALITY			DANGER	DANGER							DANGER	
GIMBAL HEAT EXCHANGE	SCHEDULE												
	QUALITY		DANGER									DANGER	
ELECTRONICS PACKAGE	SCHEDULE												
	QUALITY												
GIMBAL PLATFORM ELECTRONICS	SCHEDULE				DANGER							DANGER	
	QUALITY												
INERTIAL GUIDANCE SYSTEM	SCHEDULE					DANGER						DANGER	
	QUALITY	DANGER			DANGER							DANGER	

RELIABILITY DANGER SPOTS anticipated by PRISM.

• **Cost easily considered**—The PERT-COST analysis is a follow-on to PERT-TIME. The data for each is obtained by interviewing responsible working-level people engaged in each of the

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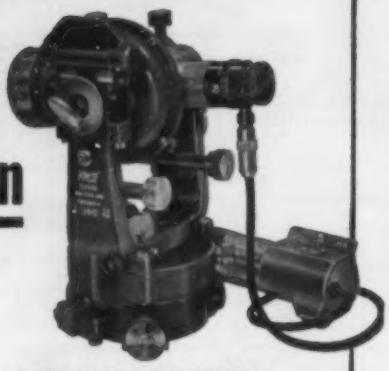

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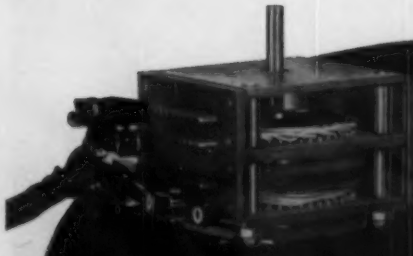

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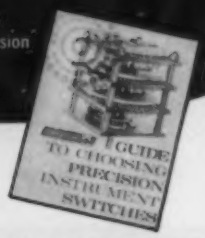

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activities that make up the project. For example, if information is needed on the time to fabricate a wing section, the production foreman in that area might be the man to talk to; and he also might be able to give cost data for PERT-COST.

Such costs are then aggregated on a network-activity basis, unlike the usual accounting procedure where costs are aggregated on a functional basis. Thus an accountant will often say that so many dollars are being spent for fabrication, for electronics, for propulsion and so forth; but he will have no easy way to fit these jigsawed cost pieces into a complete picture until the money is gone.

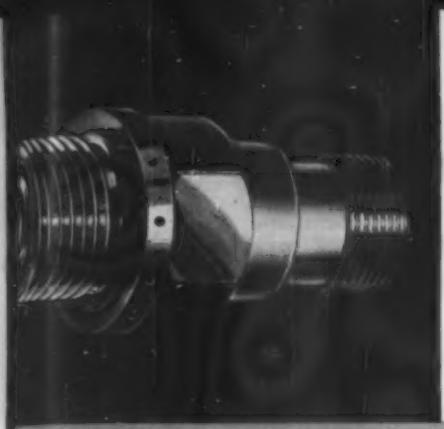
On the other hand, if costs are assigned to network activities, then the accountant still has his data for conventional financial reports; and just as important, he now has data with which all levels of management can anticipate their particular budget problems in time to do something about them. In addition, management will be able to see the choices that are open to them and the cost of each of these in terms of time and dollars.

The man who Vice Admiral William Raborn describes as "the father of PERT," Willard Fazar of the Special Projects Office, foresees PERT-COST becoming an important government and industry management tool for making time-cost tradeoffs; improving cost estimates and resource allocations; anticipating over-runs and under-runs; and justifying changes in costs, times and technical plans.

A major move toward fulfilling Fazar's prophesy is being taken. Earlier this year Hitch ordered the FY 1963 defense budget be placed on a program and project basis with ready cross-reference into the regular budget classifications. This directive is causing more than a little furor among Pentagon financial people, who now must realign their thinking as well as their data.

The team set up by the Special Projects Office to design, develop and test PERT-COST includes Dr. J. Sterling Livingston, of the Harvard Graduate School of Business Administration and of Management Control Systems, Inc., as contract supervisor; D. G. Malcolm, of Operations Research, Inc., a supervisor of the original PERT operations-research team; and Fazar as task monitor.

• **Reliability the next job**—The task of devising a technique that PERT-like will anticipate reliability problems before they arise, and perhaps even predict the reliability of a weapon system before it is built, was given to Operations Research a little over a year ago. PRISM emerged from the company's



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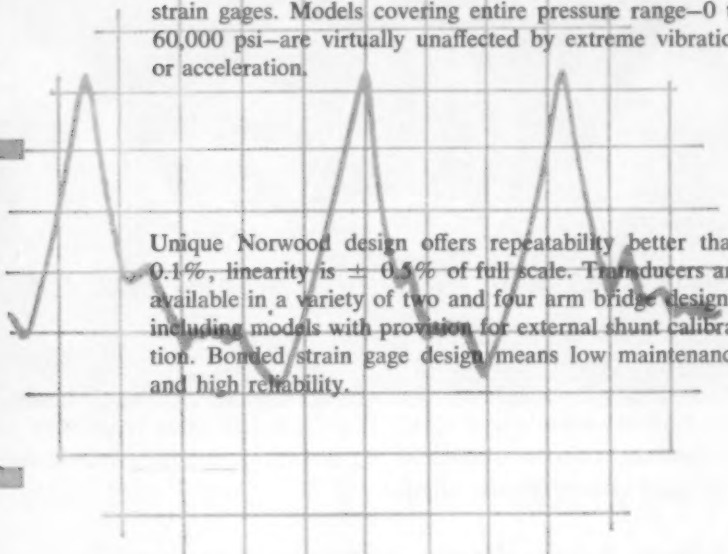
Exceedingly high frequency response characteristics (flat within ± 1 db from DC to 20,000 cps) result from the small mass and minute deflection of the assembly consisting of pressure sensitive diaphragm and strain tube with bonded strain gages. Models covering entire pressure range—0 to 60,000 psi—are virtually unaffected by extreme vibration or acceleration.



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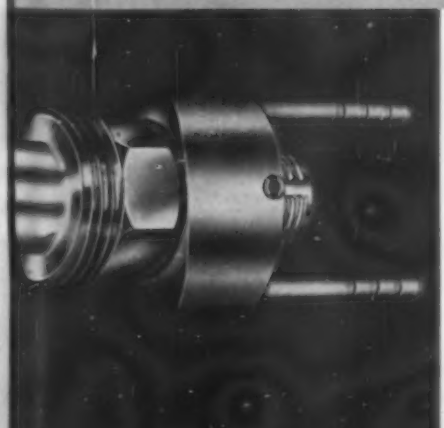

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research, a method composed of the following two systems:

1) *Reliability Maturity Index (RMI).* A method for monitoring customer and contractor compliance with reliability requirements.

2) *Reliability Performance Measure (RPM).* A method for estimating system, sub-system and component reliability.

The Reliability Maturity Index does two things: it tells how much of the reliability program has been completed, and how well. For these purposes, reliability events and activities are put into the PERT-TIME network. Thus, reliability is monitored the same way a piece of hardware is.

Reliability activities are interpreted broadly to include any action that has a bearing on the quality of a weapon system's performance. The activity does not have to be designed specifically to test reliability and would include items such as writing specifications, running laboratory and field tests and training operating personnel.

Lockheed Missiles and Space Co. is using RMI on the *Polaris* program. Because each reliability event is PERTed, and consequently its status continuously known, a summary sheet can be derived which shows how well reliability is "maturing." Called a *Schedule Compliance Evaluation (SCE),* it shows periodically the planned schedule of all reliability activities as well as when they are started and completed.

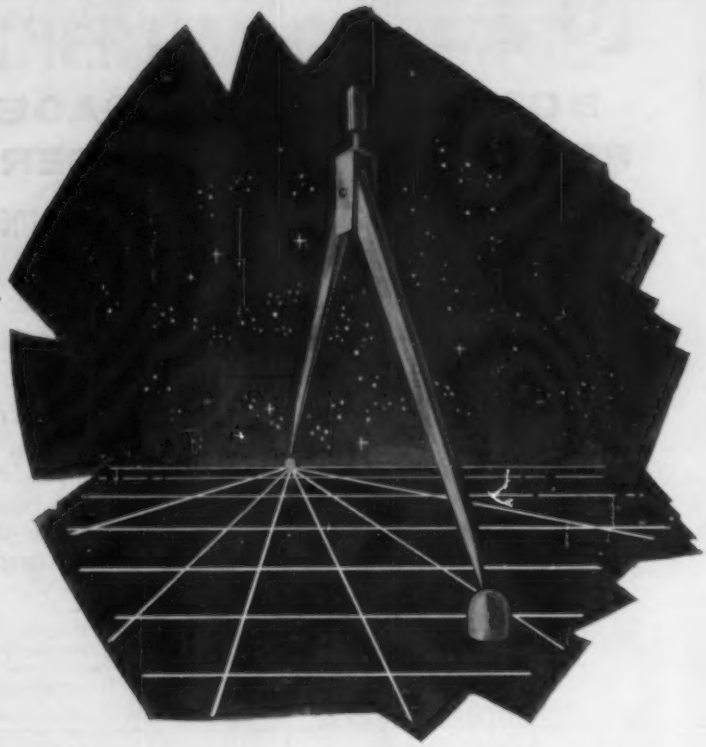
For each completed activity, a *Technical Qualitative Evaluation (TQE)* is made by a responsible reliability group. This group indicates on a percent basis its general degree of satisfaction with the quality of the completed activity.

Here is an example of the use of TQE. Often there'll be a missile flight test, and at the time the contractor may say. "Oh, yes, we've met our schedule." The test may have been a complete flop or a partial success, but it didn't do the job that was planned for it on schedule. TQE attempts to relate the degree of success of the mission with the schedule. Where there is excess disparity, a "danger" signal is flashed on the RMI summary sheet.

The Reliability Performance Measure—a means for predicting a weapons system reliability throughout its life cycle—is still being developed. The Special Projects Office hopes to have a system ready for pilot-testing before the end of the year.

What is wanted in the ultimate PERT system is a computer method in which the factors of time, cost and technical performance are inter-related.

(For another look at PERT, see the July issue of ARMED FORCES MANAGEMENT, *an American Aviation Publication.)* ■



WHAT TIME IS IT 20 MILES AWAY?

A few years ago, the answer to this question would have been unimportant. Today, however, when time measurement is used to support missile and space flights, it has been necessary to introduce a superior method of time and frequency synchronization to meet special needs.

Prior to the use of radio transmissions, time measurements were made from astronomical observations and correlated by mechanical chronometers. Radio signals were transmitted in the high frequency spectrum, but accuracy was limited due to interference and the transmission medium itself. Just a short time ago even the best techniques of time and frequency synchronization yielded accuracies of no better than one part in 10^7.

The most recent breakthrough involves the use of VLF radio transmissions in the 15 to 20 kilocycle band. Pioneering in VLF equipment and with the full understanding of this new art, ICF makes measurements of time and frequency to small parts in 10^{11} practical anywhere in the world.

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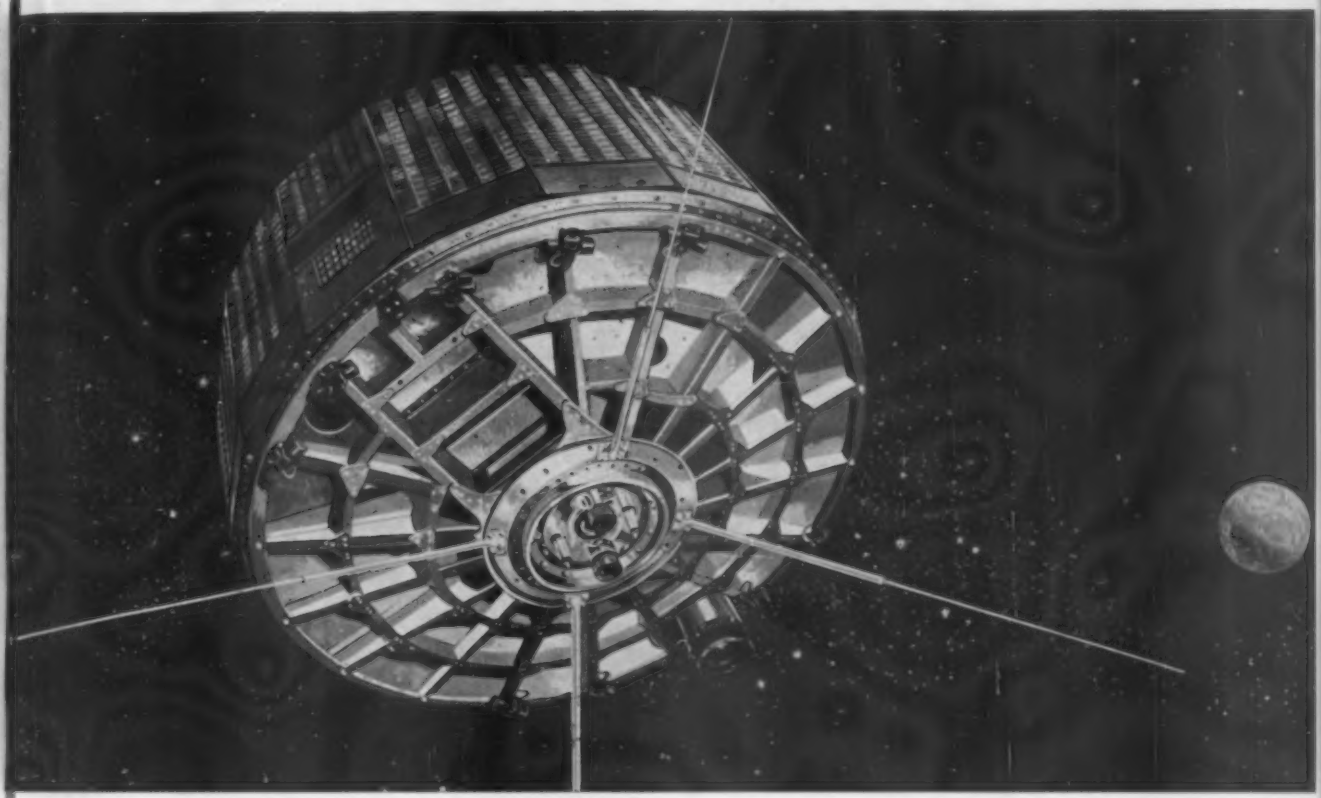
"WEATHER EYE" IN SPACE



RCA-NASA Development of TIROS Advances Progress in Worldwide Weather Forecasting

From its vantage point in space, TIROS is sending down to earth new, more definite pictures and data of the world's everchanging weather patterns to aid man in his ageless efforts to control the elements.

Incorporating revolutionary and advanced electronic equipment, TIROS was designed, developed and built by RCA's Astro-Electronics Division for National Aeronautics and Space Administration. Within its small circumference are miniature TV cameras, tape recorders, TV transmitters, command receivers, timing mechanisms, beacons and telemetry equipment. In addition, it carries new scanning and non-scanning Infra-red Sensing Devices, developed by NASA, to measure and record the heat radiation of the earth and its cloud cover, and a revolutionary new Magnetic Orientation Device to capitalize on the effects of the earth's magnetic field and maintain favorable orientation of the satellite for long periods.

RCA developments in miniaturization, reliability, computing and overall electronic activities are contributing to many of the nation's leading space and missile projects. For information describing new RCA scientific developments, write Dept. 434, Defense Electronic Products, Radio Corporation of America, Camden, N. J.

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If you would like to be listed in our *Engineering and Scientific Register*, we cordially invite you to fill out and mail the request below.

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Army-Made Fuzing Device Weighs 14 oz.

A DIGITAL programer-timer — one-fifth the size of any arming and fuzing device now in use—has been developed and flight-tested in five *Little John* test vehicles by the Diamond Ordnance Fuze Laboratories.

Containing no moving parts, the 14-oz. programer, a component for the Army's *Missile A* weapon system, is only one of many electronic devices that DOFL's Copperhead fuze system is expected to yield.

• **Copperhead program** — Several years ago the Army Ordnance Corps made a study of the state-of-the-art of the components being used in the design of its tactical weapon systems. As a result of this investigation, the Army discovered that missile designers were using components that lagged behind the electronic art by approximately five

SMALL ENOUGH to be held in the palm of one hand, the DOFL-developed programer-timer promises to replace the old-fashioned electro-mechanical devices used in warhead fuzing systems. The programer weighs only 14 ounces and has a total volume of 10 cubic inches.

years. This situation is attributed to the reluctance of the design engineer to use an untried component in a new missile system.

The Ordnance Corps, therefore, assigned to each of its arsenals an area of component development responsibility consistent with its past experience. DOFL was given cognizance over electronic fuzing and, from this mission, the Copperhead program has grown.

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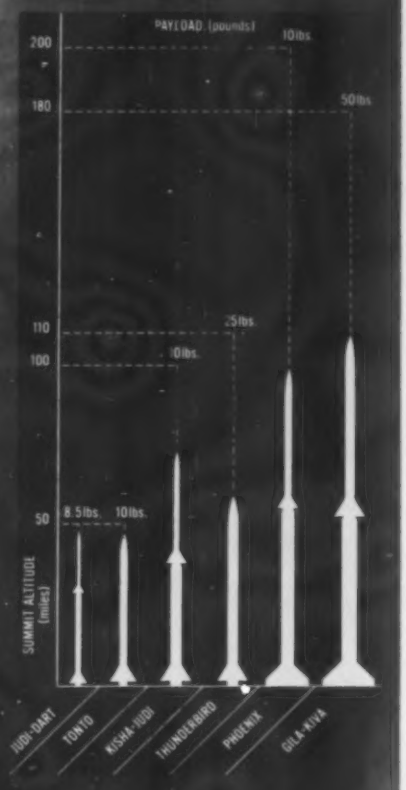

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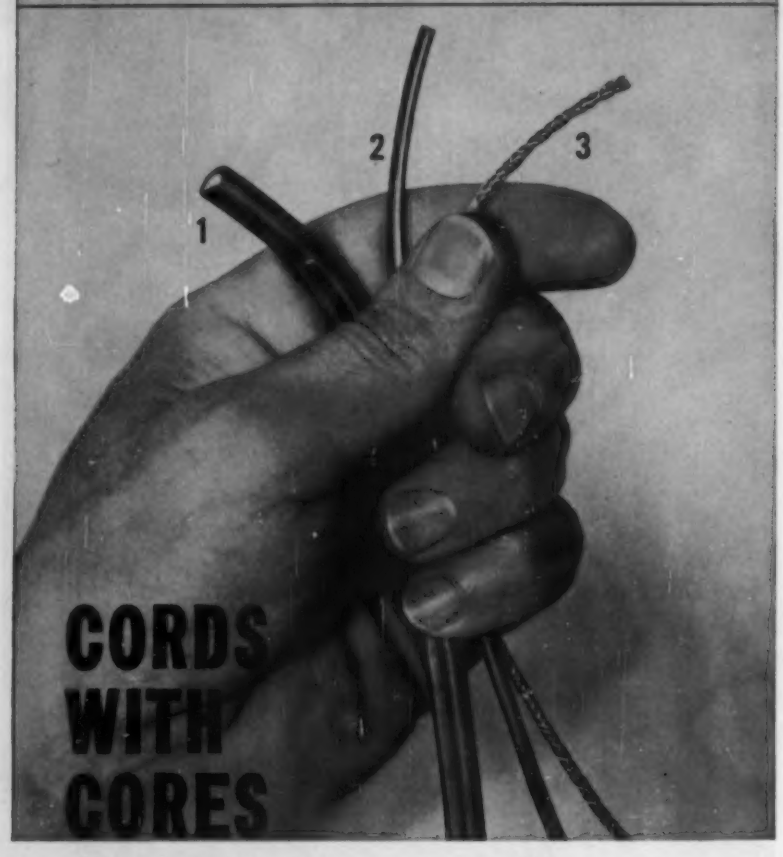

that detonate or deflagrate

Detonating Types

1. To cut, separate, rupture: New FLSC (Flexible Linear Shaped Charge) applies explosive force directionally through V-Channel. The V-shaped flexible metal tube containing a high explosive core provides a sharply defined cutting action when detonated. This instantaneous cutting tool is useful in destruct systems, and for a variety of applications where rupture or separation is required.

2. To convey a detonation without blast damage to adjacent areas: Du Pont MDF (Mild Detonating Fuse) can contain as low as 2 grains explosive per foot or can be jacketed with a variety of materials such as lead, aluminum, plastics, wire, textiles to give greater abrasion resistance and tensile strength or decrease the noise and adjacent damage resulting from the detonation. MDF can be initiated either by an electric or non-electric means. Use of the non-electrical system eliminates extraneous or static electricity hazards and provides a method for transmitting a non-electrical, non-destructive impulse.

Deflagrating Type

3. A versatile ignition device: Du Pont "Pyrocore," a flexible cord igniter, is a small diameter, continuous metal tubing containing a detonating-ignition core. Typical specifications are:

Outside Diameter: Range in Inches—0.051-0.105
Total Weight: Grams/Ft.—4-20
Approximate Velocity: Ft./Sec.—12,000-21,000

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WEAPON SYSTEMS SPECIALTIES

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The primary goal of this program is to provide the missile design engineer with a versatile, state-of-the-art component for new systems and, also, to anticipate and develop components for future missiles. The programer-timer is one of the highly integrated devices that are expected to radically change future warhead arming and fuzing techniques.

• **Functioning**—During the missile flight, the programer-timer—essentially a digital electronic clock—follows a preset program fed into it prior to launch.

Transistor output switches, capable of handling 2.0-ampere loads, are triggered to allow various warhead functions to occur. One of these outputs provides a 0.1-sec. signal at any desired place along the trajectory, five other outputs occur in a fixed sequence (8.0, 4.0, 3.9, 3.2 and 1.6 seconds in this application), and the final output represents the firing signal.

• **Advantages** — Past fuzing and arming devices have been electro-mechanical in nature. However, they have required large amounts of space and power, whereas the DOFL programer has a total size of 10 cu. in. and the timer requires only 0.1 ampere at 6.7 volts to operate.

Since the programer has no relays or mechanical elements, it is insensitive to the combination of spin and longitudinal forces created by small, spin-launched missiles. DOFL engineers feel that electro-mechanical clocks couldn't function under this combination of forces.

Finally, the digital programer-timer has an accuracy of one part in 10,000, the capability of one-tenth of a second settings, and the tactical advantage of allowing the unit commander to change

SWITCHING SECTION (top) and clock and timer sections (bottom) are heart of the new programer-timer. The unit was constructed and packaged by the Electronics Division of Cleveland Metal Specialties Company, using photo-engraved circuit techniques.

Circle No. 10 on Subscriber Service Card

the timing sequence right up to launch using a high-speed pre-set counter.

• **System description**—The programer consists of two units: a small, transistorized ground control unit and the missile-borne programer-timer.

The ground unit—a counter which is preset to the flight, or fuze, time desired—sends pulses at a 7kc. rate to a group of 11 binary counters in the programer. Each pulse reduces the maximum fuze setting by .1 seconds until the value set on the ground control unit has been reached. The time required for this operation is approximately one-sixth of a second.

The programer-timer consists of an integrator, accelerometer, timer, output amplifier and a switching array. At the heart of the system is a quartz crystal oscillator which vibrates at a frequency of 20.48 kc. and has an accuracy of one part in 1,000,000 over a temperature range of 65-165°F.

• **Binary counter array**—The pulse signal from the oscillator is fed into the first bank of 11 binary counters which have an output of 10 cps. The 10-cycle signal is then fed to a second bank of 11 binary counters, where it is stored for the timing sequence. The total time available is, therefore, 204.8 seconds. However, for the particular application of this timer, the total usable time has been reduced to 113.6 secs.

A group of 14 NOR circuits is used to read out the second group of binary counters at pre-selected times. The first four readout times are shut off after 0.1 sec.—the basic programer time interval, the fifth remains on for several seconds, and the sixth is the firing signal. All readouts would correspond to various arming and fuzing functions within the warhead adaption kit.

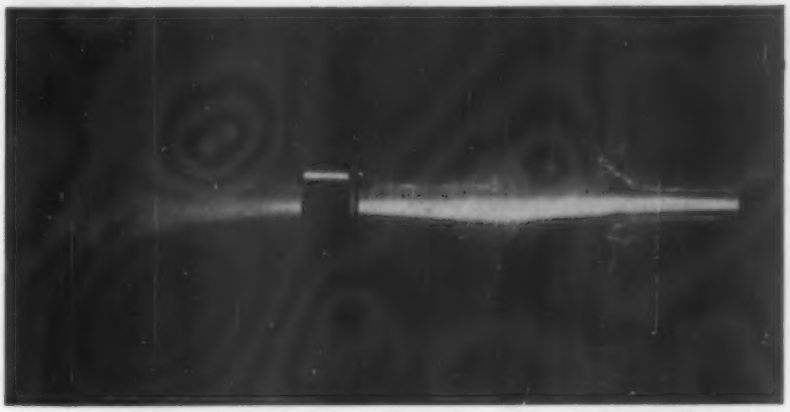
To preclude unintended or accidental arming, the accelerometer in the programer must sense a load of 20 gs for at least 400 feet before any of the arming sequence takes place.

• **Present applications**—In addition to performing as a warhead programing and arming device, the programer-timer has a number of other applications. Foremost among these are manufacturing process control, aircraft collision control, and programed satellite functions. According to one DOFL engineer, the device could be used to time-program almost anything—"even a washing machine if you wanted to spend that much money."

DOFL is already at work on a 50-hr. clock which will contain its own power supply. Also, as part of the Copperhead component development program, they are studying ways of even further improving the programer and other elements of the up-to-date electronic fuzing system that they are developing. ⌗

• ELECTRICAL ENGINEERS
• PHYSICISTS

for advanced studies of high-performance electrical propulsion systems...



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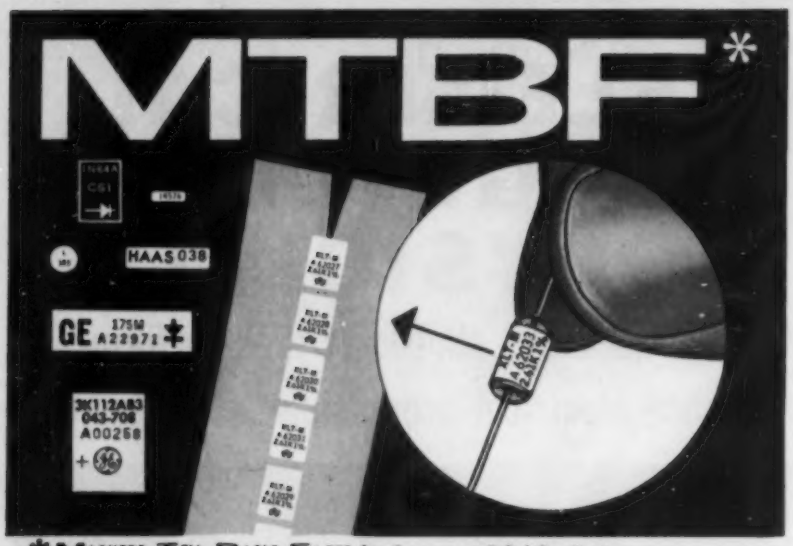

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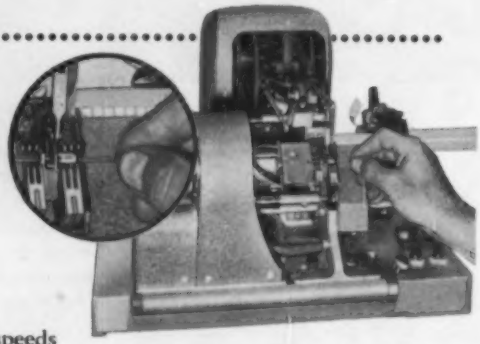

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contracts

NASA

Aerolab Development Co., Pasadena, Calif., from Goddard SFC, for vehicle system to carry a recoverable payload 1200 mi. into space and over a range of 1200 mi.; for engineering of vehicle performance and payload recovery, operational support and field engineering in connection with the *NERV II* operation. No amount disclosed.

$998,753—Minneapolis-Honeywell Regulator Co., Aeronautical Div., St. Petersburg, Fla., for furnishing necessary engineering and manufacturing services to adapt the *Centaur* guidance set to meet *Saturn* requirements; $135,502 for fabrication, test and delivery of three gyros, accelerometers, test stations and field support services for *Saturn*.

$490,000—Chrysler Corp.'s Missile Div., Huntsville, Ala., for qualification and reliability testing of *Saturn* ground support equipment subsystems and components.

$450,000—Douglas Aircraft Co., Santa Monica, Calif., for developing orbital placement techniques and engineering design specifications for the Project *Rebound* spacecraft.

$193,729—Eclipse-Pioneer Div., Bendix Corp., Teterboro, N.J., for six integrating gyros and six stabilizing gyros for *Saturn*.

$136,000—General Electric Ordnance Dept., Pittsfield, Mass., for development work on a cryogenic gyroscope.

$118,915—ACR Electronics Corp., New Highlands, Mass., for radio beacon drop buoys.

$100,000—Boeing Co., Seattle, for study of development of large rockets employing solid propellants in one or more stages and liquid propellant in upper stages.

$49,910—Space Technology Laboratories, Inc., Los Angeles, for investigation of merits of assembling *Saturn* boosters in both horizontal and vertical positions.

ARMY

$2,999,986—Northrop Corp., Nortronics Div., Hawthorne, Calif., for arming devices for *Sergeant* missiles; $3,957,124 for 112 launchers for *XM-78E3* missile.

$1,300,000—General Electric Co., Burlington, Vt., for production of safing, arming and fuzing adaption kits for *Little John* rocket.

$423,619—Western Electric Co., Laureldale, Pa., for production engineering measure for 1000 MC germanium transistor.

$258,000—University of Michigan, Ann Arbor, for research services to conduct investigation of a physical model for satellite detection.

$238,767—CTS Corp., Elkhart, Ind., for subminiature, transistor-type potentiometers.

$188,145—Landers, Frary & Clark, New Britain, Conn., for IM-108 radiacmeter.

$172,257—Stevens Institute of Technology, Hoboken, N.J., for research investigation of plasma acceleration.

$170,000—Weinschel Engineering, Kensington, Md., for development and production of prototype of a microwave measurement system.

$163,948—**W. R. Grace & Co.**, Cambridge, Mass., for meteorological balloon.

$34,500—**Western Electric Co.**, Laureldale, Pa., for facilities required in the performance of a production engineering measure for 1000 MC germanium transistor.

AIR FORCE

$11,881,000—**Reflectone Electronics, Inc., subsidiary of Universal Match Corp.**, Stamford, Conn., for electronic "mission training" systems.

$7,450,000—**Vitro Corp. of America**, New York City, for operation, maintenance and engineering of the Eglin Gulf Test Range, Fla.

$2,150,000—**General Motors' AC Spark Plug Div., Flint, Mich.**, for initial provisioning AGE and airborne spares, and spare parts in support guidance subsystem *(SM-68 Titan II B)* missile.

$1,000,000—**Siegler Corp.**, Los Angeles, for design, development and installation of electronic and antenna equipment for space and satellite programs.

$544,500—**University of California (Space Biology Lab.)**, Los Angeles, from Office of Aerospace Research, for studies of brain function and behavior.

$250,000—**Polytechnic Institute of Brooklyn**, N.Y., from OAR, for electromagnetic theory and information processes study.

$249,428—**University of California**, Berkeley, from OAR, for microwaves, solid-state antennas and radiation, bio-electronics, circuits, systems and control.

$165,000—**General Electric's Receiving Tube Plant**, Scranton, Pa., for method of increasing temperature limit of metal-to-ceramic seals from current 150° to 225°C.

$146,085—**University of California**, La Jolla, from OAR, for study of theory of solids.

$121,110—**University of California**, Riverside, from OAR, for investigation of transport processes in transition metal compounds.

$107,649—**Johns Hopkins University**, Baltimore, from OAR, for plastic wave propagation in metals at elevated temperatures.

$101,500—**Duke University**, Durham, N.C., from OAR, for microwave and radio frequency spectroscopy.

$99,884—**Recony Div., Vinco Corp.**, Richmond, Va., for rocket targets.

$73,250—**California Institute of Technology**, Pasadena, from OAR, for study of stellar compositions and related nuclear processes.

$62,905—**Adcole Corp.**, Cambridge, Mass., for design, development, construction and installation of instrumentation for rocket probe ionospheric measurements.

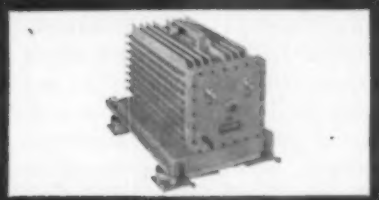
$49,381—**Ionics, Inc.**, Cambridge, Mass., for development of lightweight fuel cell which can be used to generate electric power in satellites and space vehicles.

$27,300—**Boeing Co., Aero-Space Div.**, Seattle, for modification and repair of spare parts for *Bomarc* system; $133,638, prepare time compliance technical order in accordance with engineering change proposal, provide 2 ea. kits, spares and required revisions to technical orders applicable to *Bomarc* weapon.

WHEN HIGH QUALITY *is the Criterion in Airborne Telemetry...*

Vitro Electronics Nems-Clarke airborne telemetry equipment should be the unquestioned choice in applications where proven performance and the utmost dependability outweigh considerations of size and weight. A thoroughly equipped system of this nature might, for instance, have Vitro Electronics Nems-Clarke Type 1403 Airborne Telemetry Receivers. Effective supporting auxiliary equipment in such an installation would include:

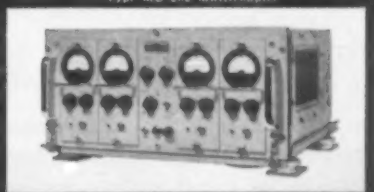
Preamplifiers for amplification and improvement of received signals ☐ Multicouplers for distribution of received signals to as many as 8 receivers ☐ Phase-lock telemetry receivers—key units of a system ☐ Diversity-combiners combining reception of up to 4 receivers into one output as good as best single receiver output—or better than equal outputs from all associated receivers ☐ Spectrum display unit to each 4 receivers—for visual monitoring of received signals to determine character and modulation



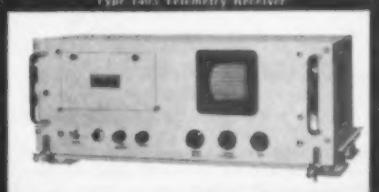
Type PR-202 Preamplifier

Type MC-202 Multicoupler

Type 1403 Telemetry Receiver



Type DCA-2000 Diversity-Combiner



Type SDU-201 Spectrum Display Unit

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names in the news

Dr. R. M. Wilmotte: Research and engineering specialist in electronic communications, appointed project manager to head Radio Corporation of America's development and construction of the *Relay* experimental communications satellite.

Edward Ray: Appointed project manager of space power; **Victor E. Boccelli,** manager of technical facilities planning, in the Projects Planning and Special Programs Operation of General Electric's Missile and Space Vehicle Dept., Philadelphia.

Dr. Webb Haymaker: Internationally-known neuropathologist, appointed assistant director for Life Sciences, NASA's Ames Research Center, Moffett Field, Calif. Dr. Haymaker also will be director of the Life Sciences Research Laboratory at Ames. He expects to remain at NASA headquarters in Washington, D.C. until he reports to Ames in the fall.

Col. Leslie B. Williams, USAF: Assigned to the Department of State as special assistant for space and atomic energy matters. For the past three years, Williams has served on the aerospace nuclear propulsion and power staff of the Reactor Development Division, Atomic Energy Commission.

Sal LaFaso and **S. W. Kerkering:** Appointed managers of the Administration and Production Departments, respectively, at Aerojet-General Corp.'s Atlantic Division, Frederick, Md.

Chester W. Nimitz, Jr.: Formerly with Texas Instruments, Inc., elected a vice president of Perkin-Elmer Corp., and general manager of its Instrument Division. **Henry F. Brockschmidt,** general manager of International Operations, and **Robert H. Sorensen,** general manager of Electro-Optical Division, also elected vice presidents of Perkin-Elmer.

Dr. Donald J. Shombert: Formerly with Merck and Co., joins Columbia Broadcasting System Laboratories, Stamford, Conn., as manager of the Electron, Ion, and Molecular Beam Section of the Surface Physics Dept.

Eugene Tatom: Recently retired as Captain, USN, after 30 years service joins United Aircraft Corp.'s Norden Division as chief of research and development.

Vincent P. Huggard: Former assistant chief of the Requirements Division for the Deputy Chief of Staff for Logistics, USA, joins the Washington office of Radio Corporation of America as manager, Army affairs, Defense Electronic Products.

Harmon Q. Avera: Former assistant department head and senior optical engineer (photogrammetric), Itek Corp., ap-

pointed head of the Photogrammetric Research and Development Dept., Bausch & Lamb, Inc., Rochester, N.Y.

Leo W. Killen: Named assistant to the president of Autonetics, a division of North American Aviation, Inc., Downey, Calif. Killen was formerly director of sales and European operations and acting executive vice president for Fairchild Stratos Corp.

Sid W. Farley: Named manufacturing manager, Sparton Electronics Division of Sparton Corp., Jackson, Mich. Prior to joining Sparton, Farley was with Northrop Corp.

Dr. Patrick Conley: Former general manager of the Air Arm Division, elected a vice president of Westinghouse Electric Corp., Pittsburgh, with responsibility for industry engineering apparatus, service and the newly-created industry systems department. **M. B. Wyman** will continue as manager of apparatus products service and **Paul R. Sprowl** has been named manager of the industry systems department.

William A. Sibley and **Michael E. Maes:** Join Rocket Research Corp., Seattle, as research engineers.

A. T. Colwell: Director and former vice president of Thompson Ramo Wooldridge, Inc., elected to the board of directors of The Gabriel Co., Cleveland, Ohio.

Dr. Vee Chang Tsien: Appointed technical assistant to the vice president, Marine Equipment Dept., Nortronics Division of Northrop Corp. Before joining Nortronics, Dr. Tsien was technical staff member at Avco/Rad responsible for development of ICBM control systems.

C. B. McKoewn: Named general manager of B. F. Goodrich Co.'s Aerospace and Defense Products Division. McKoewn formerly was manager of the Aviation Products Division, which has been replaced by the new division.

George B. Espey and **Melvin H. Jones,** research engineers, and **William F. Brown,** chief of the Strength of Materials Branch, NASA's Lewis Research Center, Cleveland, Ohio, received the Charles B. Dudley Medal from The American Society for Testing Materials. The award was presented for a paper of outstanding merit constituting an original contribution on research and engineering materials.

Theodor H. Braun: Appointed vice president and director of plans and operations; **Dr. Launor F. Carter,** vice president and director of research, for the System Development Corp., Santa Monica, Calif.

Pat Minervini: Named engineering manager of Military Electronics Division of Daystrom, Inc., Archbald, Pa. He will be succeeded as chief product engineer by **Bernard Plevyak.**

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By Robert H. Miller
Vice President
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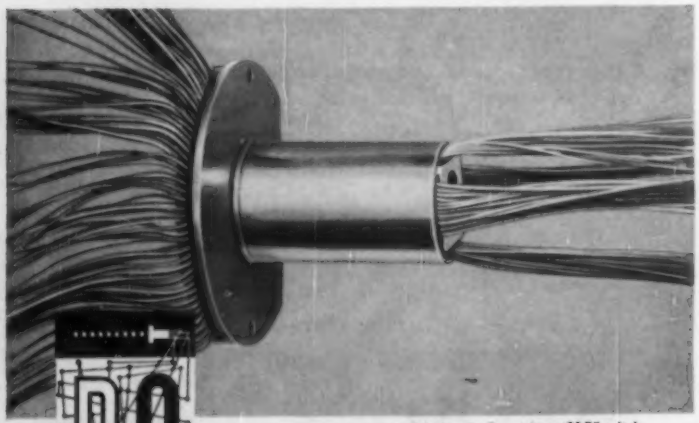
In inertial measurement units, as in most air or missile borne equipment, space and weight are vitally important factors. As over-all volume is reduced, the size limitations on components become more severe. Micro-miniaturized slip ring capsules pioneered by Poly-Scientific, the use of which is growing steadily, permit great space saving by placing the slip ring under the gimbal bearings, thus utilizing formerly wasted space.

The large number of circuits in multi-gimballed applications require extremely dense axial spacing of slip rings. Advanced techniques permit Poly-Scientific to manufacture by time-tested and proven methods slip ring capsules with ring spacing of .015" pitch. This size reduction is being made without sacrificing high dielectric strength, current ratings, reliability or long trouble-free life.



84-circuit Capsule—.015" pitch

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products and processes

Digital Modules

A line of silicon digital modules which operate at low power and can withstand wide operating conditions is available from the Delco Radio Division of General Motors.

The modules will operate on from 4 mw. to 10 mw. of power per logic stage. Operating temperature range is −10°C to +100°C under conditions of near perfect vacuum, high shock and high humidity.

The basic set of modules includes a bistable multivibrator, a diode NOR gate, a power driver, a monostable multivibrator and an astable multivibrator.

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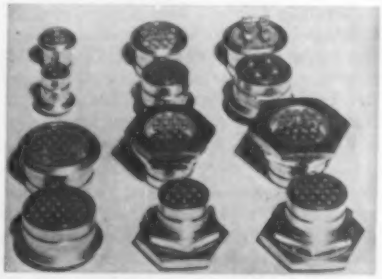
Hermetic Connector

A quick-disconnect hermetic receptacle with socket-contact insert configurations has been developed by the Deutsch Co. This connector features a full compression glass insert on the rear and a resilient silicone insert in front. The coupling mechanism is of the push-pull, ball-lock type.



Designed for extreme environment applications where a socket insert would be desirable, this connector mates with all plugs in the Detusch DM and DS series. In addition, a complete interfacial seal is obtained when used with the DS series plugs with crimp-terminated, snap-in contacts.

Circle No. 226 on Subscriber Service Card

Inflatable Mobile Antenna

A lightweight, compact, inflatable helical antenna for mobile and transportable tracking systems is available from Andrew California Corp. This 4-ft. antenna, Type 53000-2N, can be put into operation in a matter of minutes with a conventional hand pump.

Incorporating bifilar helices, the gain is greater than 9.5 db over isotropic with a VSWR of less than 1.5:1 across the antenna's (215-265 mc) bandwidth.

Circle No. 227 on Subscriber Service Card

Circuit Analyzer

A circuit analyzer which analyzes from 500 to 18,000 circuit points automatically is available from Autonetics, a division of North American Aviation, Inc. It checks wire continuity of complex electronic circuits automatically by comparing two units against each other. The unit will display steady light patterns to enable qualification of the "master" to wire lists. This equipment eliminates the need for tape or card programing and requires no matrix chart or plug board programing.

Circle No. 228 on Subscriber Service Card

Irradiated Wire

Radiation Materials, Inc. has completed development of an irradiated polyolefin wire and is activating plans for full-scale production and marketing of the material. The irradiated wire possesses radiation resistance, temperature and dielectric characteristics which are especially suitable for the environments encountered in satellite and ballistic missile programs.

The wire's temperature characteristics enable it to resist burning or shrinkback by soldering irons or soldering baths, making it highly applicable to commercial and military miniaturized electronic assemblies where soldering operations in manufacturing present problems.

Circle No. 229 on Subscriber Service Card

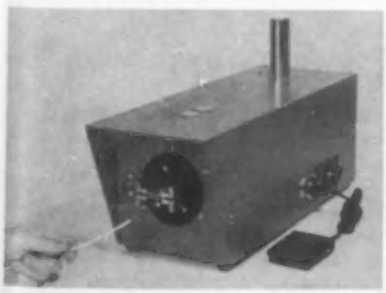
Strain Gage

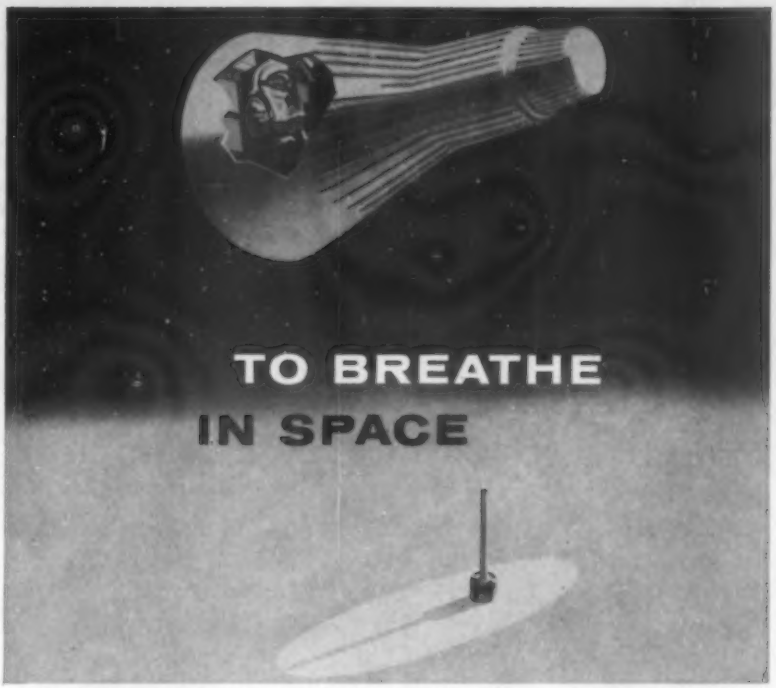
A fast-setting epoxy cement for strain-gage application has been put on the market by the Instruments Division of The Budd Co. B-3 cement sets in only three hours at room temperature, but heat can shorten this. Feature of the B-3 cement is that, although it sets much faster than standard epoxy cements, it still allows a strain gage to be aligned while cement is setting up, so that it may be positioned with great precision. This also facilitates the use of jigs, fixtures and other tooling.

Circle No. 230 on Subscriber Service Card

Wire Stripper

Western Electronic Products Co. is marketing the Model AT-1 Auto-Therm, a semiautomatic Thermal-type wire stripper capable of stripping over





The first American Astronaut in Space will rely on a continuous supply of oxygen metered through intricate valving which has been designed by Garrett Corporation, AiResearch Manufacturing Division, engineers with the technical assistance of Stillman Rubber Company experts.

To produce a reliable poppet in sub-miniature size which would meet micro-precision requirements, Stillman Laboratories developed a special compound designed especially for NASA's Project Mercury. This compound, TH-1080, was bonded under critical conditions to the stainless steel body and shaft, and the poppet then ground to precision tolerances.

By close coordination with Garrett engineers, Stillman technicians were able to produce this precision part in only four days from the design release date. Stillman's reputation for quality and reliability in the aircraft and missile industry, together with years of technical experience and know-how, enabled them to produce and deliver the all-new, sub-miniature poppet in record time. These same qualities of experience and technical abilities are available to any industry or manufacturer who specifies the very finest of static and dynamic sealing.

For further information, write to:

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1000 ends per hour. It strips virtually any type of insulation, including Fiberglass, Teflon, Kel-F, Nylon, Rayon, Dacron, polyester, vinyl, polyethylene, in sizes from smaller than #30 to wire in excess of 3/8-in.-diameter. The stripping head consists of two pincers-type heavy-duty heating elements. A foot-switch-actuated solenoid causes the element jaws to close and to rotate if desired.

Circle No. 231 on Subscriber Service Card

Boosted Wire Capacitors

Users of Ohmite Mfg. Co.'s tantalum wire electrolytic capacitors can now obtain higher maximum capacitance in most of the existing case sizes. Some of the gains in maximum capacitance are considerable and stem from improvements in processing. For example, the Size E case (.812 x .134 Dia.) has increased from 80 mfd maximum at 1.25VDC to 150 mfds; at 16VDC the increase is from 19 to 25 mfds. The greatest gains were achieved in the larger case sizes and in the lower voltage ratings. The thirteen extremely small case sizes now provide a range from 0.01 to 150 mfds and voltages to 150, depending upon case size.

Circle No. 232 on Subscriber Service Card

Tape-To-Tape Converter

A versatile tape-to-tape converter for conversion of differing input-output media and codes is available from Daystrom's Control Systems Div. The Daystrom TMTC (Tri-Mode Tape Converter) is available in models to convert perforated paper tape to magnetic tape, magnetic to paper, or paper to paper. The TMTC's accept and generate all paper tape and magnetic tape codes now in use in data processing. Any paper tape data such as accounting records and engineering tests can be read by a TMTC Converter at a speed of 300 characters per second and convert in seconds to magnetic tape for high-speed computer use, re-transmission or storage for future use.

Circle No. 233 on Subscriber Service Card

A-C Coupling Card

Computer Logic Corp. is marketing a plug-in logic coupler card, Model AC-1. The solid-state coupling card is compatible with the 200 kc series of

digital logic circuit modules manufactured by the firm. Useful in ac-coupled digital systems, the Model AC-1 allows a reduction in the number of basic digital logic cards used in the system. The coupler card is also used in triggering one-shot delays.

Circle No. 234 on Subscriber Service Card

Regulated Power Supply

A solid-state regulated power supply with automatic voltage-sensing and an input-output efficiency nearly 50% higher than that of comparable equipments is being marketed by Weber Electronics Division of Weber Aircraft Corp. Used for powering components on ready-to-fire missiles, the unit employs safety factors to sense remote

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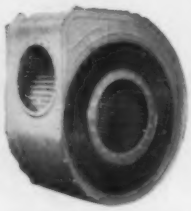
TIROS STRUCTURE



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Components built by Lavelle have met the challenge of change in the aerospace industry for more than two decades. You can rely on this proven experience in making sheet metal parts and assemblies to exacting specifications—for missiles, jet engines, space vehicles and airframes . . . electronic systems and equipment for ground support.

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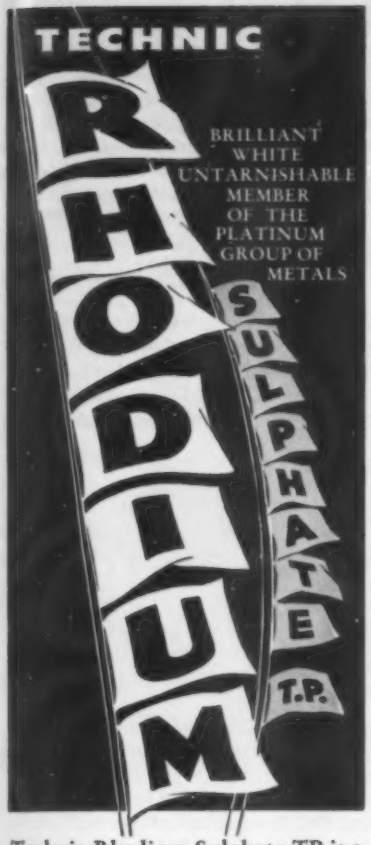
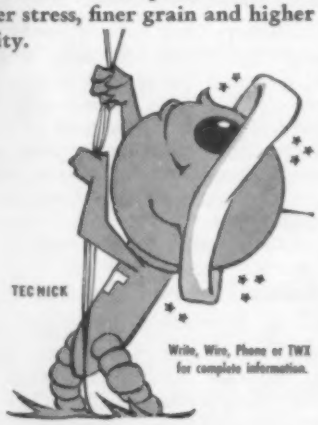


Technic Rhodium Sulphate TP is a new and superior concentrate. It is ideally suited to meet all electroplating specifications, and offers to electroplating metallurgists new possibilities for the adaptation of a Rhodium electroplate that has lower stress, finer grain and higher purity.



Technic Inc
P.O.Box 965
Providence, 1. R. I.
STuart 1-6100
Plant: Cranston, R. I.

Chicago Office: 7001 No. Clark St.

Circle No. 16 on Subscriber Service Card

malfunction and to regulate (locally and at load), or to shut off power in the event of over-voltage or over-current at the load.

The rack-mounted power supply has separate electronic and magnetic overload-sensing systems; either can independently sense voltage and current, and function to adjust or shut off as required.

Circle No. 235 on Subscriber Service Card

Dry-Film, Bonded Lubricant

Molykote X-15, an inorganic-bonded, dry film lubricant with a useful temperature range of from −300 to +1200°F is being produced by The Alpha-Molykote Corp. under a licensing agreement. In addition to its wide temperature range, Molykote X-15 is insensitive to liquid oxygen; has proven to be unaffected by up to 5×10^8 roentgen gamma radiation; retains its lubricating properties under vacuums up to 10^{-9} mm of Hg; and is easy to apply in either shop or field.

Circle No. 236 on Subscriber Service Card

Direct Drive Counter

A line of high-performance, low-torque, direct-drive counters for digital readout applications where plus and minus, right and left, or directional readings are required is available from Veeder-Root, Inc. Designed for applications in navigation instruments, missile ground support equipment, ground approach systems, machine tool indicators, gauging instruments, and tracking equipment, the line will include 27 different units both in-bank and in-line models.

Circle No. 237 on Subscriber Service Card

Data/Photograph Correlator

A digital recording head for correlating digital data and photographic images on the same photographic film has been developed by FMA, Inc. Mounted inside a camera, the miniature device provides a means of recording instrumentation data such as test parameters (e.g., velocity and temperature) along with the photography normally required in such operations as missile-testing, sled-testing, or destruction tests. The problem of synchronizing and collating several recording media is thus eliminated. Instrumentation data are directly associated with the pictorial recording.

Circle No. 238 on Subscriber Service Card

Portable Antenna

Temco Electronics Division of Ling-Temco Electronics, Inc., has available a lightweight, 4- or 7-turn helical antenna. Gain, at center of band, is 10.5 decibels at 4 turns, 13.5 decibels at 7 turns. Beam width is 52° and 40° at same specifications. Impedance is 50 ohms,

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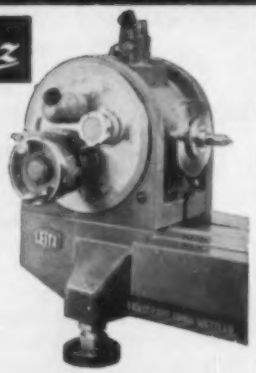

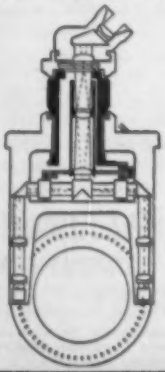

It compensates for run-out, the most common source of error. Working accuracy ± 1 second of arc.

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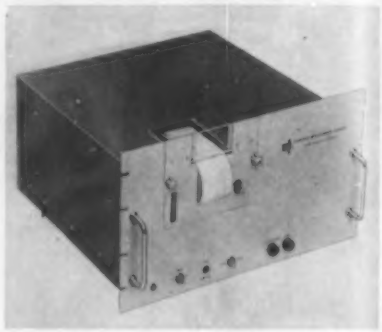
and voltage standing wave ratio is less than 2 to 1. Frequency range is 215 to 265 megacycles per second, with other frequencies available upon special order.

Circle No. 239 on Subscriber Service Card

Front-Feed Printer

A digital printer with an all-transistorized drive is available from Computer Measurements Co. The Model 400DT has a convenient, simple and easy-to-read front-tape feed and can be either cabinet- or rack-mounted. The digital



printer can be coupled to any electronic counting equipment or control system that provides a 1-2-4-8 binary coded decimal output with a voltage swing of −6 volts. It is designed to operate directly with any of the CMC solid-state digital instrumentation.

Circle No. 240 on Subscriber Service Card

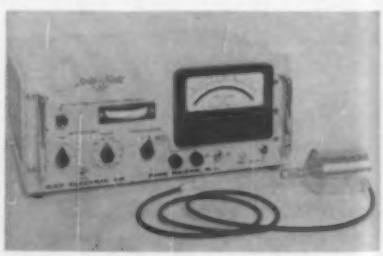
Midget Heat Sink

Hunter Tools is now producing a small, lightweight heat sink. It is 1¼ in. long and has slimmer points to get into confined areas. These heat sinks are made of Berylco 10 because of its high thermo-conductivity and good spring characteristics. The handles are covered with plastic to keep finger area cool and comfortable.

Circle No. 241 on Subscriber Service Card

Noise Figure Test Set

The Auto-Node, an accurate, wide-range noise figure measurement test set, is available from Kay Electric Co. The unit provides highly precise noise figure measurement from 0 to 15 db at



frequencies from 5 to 2000 mc. It contains all the necessary equipment for making noise figure measurements. An I-F range of 7.5 to 150 mc (with a required input noise level of −10 db to 0 dbm over a 3-mc bandwidth) is provided. The I-F frequency covers the range of most I-F's presently used. The AGC has a dynamic range of 12 db.

Circle No. 242 on Subscriber Service Card

Nose Cone Grinder

A dual-table contour grinding machine using a three-dimensional master is available from Frauenthal Division of the Daydon Engineering Corp. An automatic electro-hydraulic tracer system using a master on the first table produces a duplicate on a second table and within ±0.0005 in. For other applications, a grinding spindle may be added to use with the second table for grinding two identical parts, one on each table. The Model 926 machine was designed to grind Pyro-Ceram nose cones, but may be adapted for other parts.

Circle No. 243 on Subscriber Service Card

Cold-Wall Vacuum Furnace

A line of standard high-temperature cold-wall vacuum furnaces able to produce temperatures up to 2500°C at $1x10^{-5}$ mm Hg pressure has been developed by Vacuum Specialties, Inc. Designed for high-temperature materials research, development, and production programs in the electronics, space, and nuclear fields, the new line consists of 27 models in nine different sizes. The units employ internally heated hot zones which may be arranged either vertically or horizontally. Sizes range from 60 to 2700 in.^{3}.

Circle No. 244 on Subscriber Service Card

Silicone Wire Insulator

A silicone rubber compound, SE-9007, for use as wire and cable insulation has been put on the market by the Silicone Product Department of G.E. Similar to the SE-975 family of compounds, the material is designed primarily for high-quality aircraft, hook-up, motor lead and similar wire applications. It is somewhat softer than SE-975 grade, offering excellent processing characteristics, easy milling, high extrusion speeds and very good diameter control.

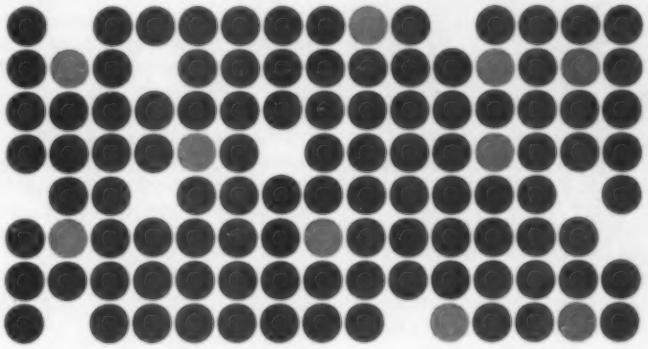
Circle No. 245 on Subscriber Service Card

Monitoring Transformers

A line of transformers for precision monitoring of pulse currents at voltages up to 300 KV has been developed by Pearson Electronics, Inc. These units are used with a standard oscilloscope for monitoring of pulse currents from milliamperes to tens of thousands of amperes in high- or low-voltage conductors, charged particle beam currents

SUPERVISOR

IN THE FIELD OF DIGITAL DATA TRANSMISSION



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Just such an opportunity is now available at the Weather System Center for an engineer experienced in the area of digital data transmission via land communication lines. The individual selected will supervise and direct: 1) investigations and analysis of present and planned message traffic on civilian and military weather circuits. 2) study both high-speed and low-speed digital data and graphic circuits. 3) design an improved communication system to Government specifications. 4) evaluate communication equipment and procedures to obtain efficient system design at reasonable cost.

Because of the pioneering nature of the project, this position offers exceptional challenge and opportunity to a truly creative engineer capable of originating major design concepts. It can be an introduction to a satisfying lifetime career in a new field with unusual growth possibilities.

Minimum requirements: Engineering degree preferably in electrical or communication engineering. Eight to ten years experience with emphasis on experience in the digital communications area.

Please send resume *(including salary requirements)* to MR. F. T. FINCH:

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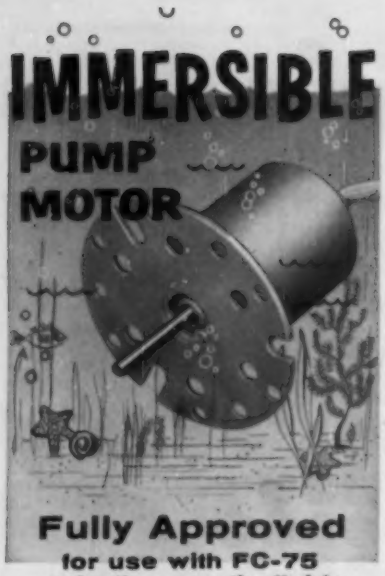

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The unit is fully compatible with fluorochemicals and will not contaminate such fluids.

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in accelerators, and electron currents in electronic devices. The specifications feature fast rise-time (20 millimicroseconds), low droop (0.1% to 0.0005% per microsecond, depending on model), high-output amplitude accuracy (+1%, −0%), and ability to monitor currents at very high voltages up to 300 KV.

Circle No. 246 on Subscriber Service Card

L-Band Coaxial Isolator

Miniature L-band Coaxial Isolators with improved electrical characteristics are available from E & M Laboratories. These units, 6.45 in. long and less than 2 lbs. in weight, have been reduced to one-half the previous size. Standard units covering the frequency range of 1.0 to 2.0 kmc/s have a 10:1 isolation/insertion loss ratio and a VSWR of 1.15 maximum. Narrower band units are also available with much higher isolation/insertion loss ratios.

Circle No. 247 on Subscriber Service Card

Tracing Attachment

True-Trace Corp. has available the Mark X tracing attachment for vertical turning and boring machines. A feature that further enhances the versatility of machine tools is the Mark X VTL tracing attachment which converts a vertical

turning and boring machine into a contour turning lathe. This compact attachment mounts to the ram or turret of the machine, or many be installed in place of the side head—depending upon the individual machine and job requirements. Being an attachment, no machine conversion is required.

Circle No. 248 on Subscriber Service Card

Rotary Accelerator

Pacific Southwest Instrument Laboratories is marketing a rotary acceleration generator designed for test qaulification programs and production testing. The 20-in.-diameter spin table, designated as Model RA-ATC-500-1 tests dynamic characteristics of instruments and other scientific objects from 3 g to 500 g/lbs. The rotary acceleration gen-

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SUB-MINIATURE PHOTOELECTRIC TRANSDUCERS

MODEL 200-13 BIT ACCURACY

Compact Type 23 synchro-mount with NO BRUSHES, NO GEARS, LOW TORQUE. Steady light up to 20 rpm. Diameter: 2.6″, Length: 3 5/16″, Weight: 1.25 lbs.

MODEL 202-13 BIT ACCURACY

Compact Type 23 synchro-mount with flashing light up to 500 rpm. Low torque with no brushes or gears. Diameter: 2.6″, Length: 4 7/8″, Weight: 1.7 lbs.

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HAWS SAFETY FOUNTAINS

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7900 Series—Maximum coverage eye/face-wash. 6 spray outlets in extra large stainless steel bowl set up soft, drenching mist for positive first aid. Large hand valve.

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7700 Series—Eye/face-wash simultaneously sprays water from perforated copper ring and fountain heads. Stainless steel bowl.

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Instantly flood the body with torrents of rushing water to wash away injurious contaminants. Your choice of single head or multiple nozzle showers; available with hand or foot valves.

Model 8590—Multiple Nozzle Shower instantly drenches victim from all angles. Large hand valve.

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Circle No. 23 on Subscriber Service Card

erator employs dual controls to provide an infinite variable platform speed within an operating range of from 10 to 2000 RPM. The course RPM speed is established by an initial control setting while a second control provides fine RPM trimming.

Circle No. 249 on Subscriber Service Card

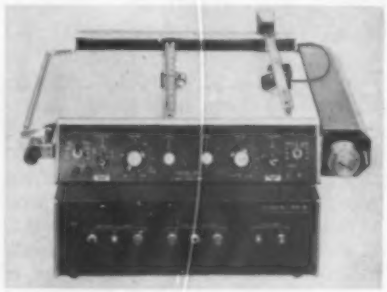
Telemetering Transmitter

Wiley Electronic Products Co. has developed a telemetering transmitter for use in rotors of high-speed rotating machinery. Data is transmitted on the subcarrier oscillator frequency directly, with no RF carrier, through capacitively coupled non-contacting slip rings. No FM-FM receiver is required, and the subcarrier frequency deviations of ±40% are readily obtained without complication. The transmitter is a bridge-controlled, subcarrier oscillator for use with strain gage bridges.

Circle No. 250 on Subscriber Service Card

Time Delay Simulator

Model 2D-5 Transport Delay Simulator is an instrumentation system which easily reproduces any time delay encountered in a process control or experimental laboratory situation. Developed by F. L. Moseley Co., the system



combines a standard Autograf Model 2D-X-Y Recorder with its roll chart accessory and a Moseley Type F-2 Line Follower carried on the recorder's second arm. Any function can be recorded by the recorder's writing pen and, at any desired time later, can be read back by the line follower.

Circle No. 251 on Subscriber Service Card

Film Shift Registers

Servomechanicms/Inc. has available thin magnetic-film shift registers. The registers exploit a magnetic domain interaction or domain boundary-extension phenomenon inherent only to magnetic films. This phenomenon, which allows the action of infinitesimal magnetic dipoles within the film and their interactions upon each other to be controlled, yields shift registers in which the data processing is performed completely inside the film.

Circle No. 252 on Subscriber Service Card

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molded stock saves tooling up for prototype parts

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The superiority of R/M Pyrotex® molding compounds stems from the use of extra-long spinning grade asbestos fibers.

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A rugged series of quick-connect-disconnect couplings which sustain operating pressures up to 3000 psi is available for applications ranging from electronic cooling to hydraulic systems from E. B. Wiggens Oil Tool Co., Inc. Available in eight models, the series (called Inst-O-Matic) withstands vibrations of 20 g's at 2000 cps. Coupling disconnects under pressures of 3000 psi and connects under pressures of 50 psi.

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Micro Volt-Ammeter

An electronic (all-Transistor) d-c micro volt-ammeter operated by an automatically recharged nickel-cadmium battery is available from Dynamics Instrumentation Co. The Model 4072 has full-scale ranges of voltage from 100 microvolts to 1000 volts, and current from 10 millimicroamperes to 1 ampere. Accuracy on all ranges is ±1% of full scale. The overload protection circuit makes it possible to safely apply up to 100 volts on the microvolts ranges, and 1000 volts on the upper ranges.

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High Speed Light-Pulse

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Separate Output Sequencer

A versatile sequencer designed to produce signals on separate output lines at a rate equal to the input clock is available from Alpha-Tronics Corp. Type SSL-101 utilizes a d-c start for

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As the initial flight test of the Minuteman revealed the success of America's first solid propellant ICBM, we at Fenn took an extra measure of pride in our precision parts in the vector nozzles.* It added missile components to a long list of other precision Fenn-made parts that fly. If you need a reliable source . . . with long experience . . . completely modern facilities and thinking, we would like to tell you more about Fenn. Copies of our Facilities Folder and Facts About Fenn are yours for the asking. The Fenn Manufacturing Company, Fenn Road, Newington, Connecticut.

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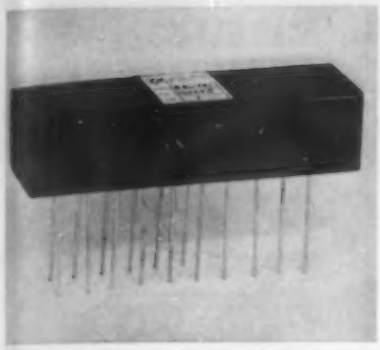

developing the first output. The logic incorporated into the design will prevent more than one output being energized at one time, thereby eliminating the possibility of any false signals. This logic will also enable one sequencer to drive another in a decade fashion, and still prevent the appearance of more than one signal simultaneously on either deck.

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Power Measuring Device

Consolidated Aviation Equipment, Inc., is marketing a solid-state power sensor which provides an in-line measurement of true power over a wide frequency range extending from d-c into the very high frequency region. True power of complex waveforms is measured. Several models provide sensitivities enabling a measure of power ranging from the order of a few milliwatts to many hundreds of watts. The insertion loss of the device is negligible and it is physically small.

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Hi-Gain Signal Amplifier

A transistorized, high-gain airborne d-c to d-c signal amplifier is available from the Electronics Division of Statham Instruments, Inc. The SA9-O signal amplifier features higher gain, a wider temperature range, smaller size and excellent stability. The unit provides complete utilization of low-level d-c signals from thermocouples, thermal sensing to bridges, and d-c excited transducers. It has been designed to operate under extreme environmental conditions.

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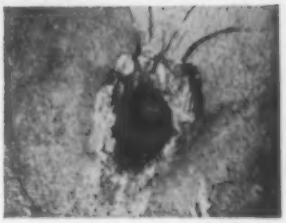

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—when and where—

JULY

Fourth International Conference on Medical Electronics Combined with 14th Annual Conference on Electronic Techniques in Medicine & Biology, Waldorf-Astoria Hotel, New York City, July 16-21.

Western Plant Maintenance and Engineering Show, Pan Pacific Auditorium, Los Angeles, July 18-20.

Structural Engineering Aspects of Atomic Shelter Seminar, Pennsylvania State University, University Park, July 23-Aug. 4.

AFOSR, Differential Equations in Nonlinear Mechanics, cosponsored with Martin's RIAS, Air Force Academy, Colorado Springs, Colo., July 31-Aug. 4.

Physics of the Solar System and Re-entry Dynamics, National Science Foundation, NASA, Virginia Polytechnic Institute, Blacksburg, July 31-Aug. 11.

AUGUST

Space Age Astronomy, symposium sponsored by Douglas Aircraft Co., Cal-Tech, Pasadena, Aug. 7-9.

American Rocket Society/Stanford University Guidance and Control Conference, Stanford University, Palo Alto, Calif. (some sessions classified), Aug. 7-9.

Society of Photographic Instrumentation Engineers, 6th Annual Technical Symposium, Ambassador Hotel, Los Angeles, Aug. 7-11.

Survival in the Nuclear Age-Executive Management Seminar, Pennsylvania State University, University Park, Aug. 13-18.

International Astronomical Union, 11th General Assembly, Pasadena, Calif., Aug. 15-24.

American Rocket Society International Conference on Hypersonics, Massachusetts Institute of Technology, Cambridge, Aug. 16-18.

National Naval Aviation Meeting, Institute of the Aerospace Sciences, San Diego, Calif., Aug. 19-24.

Welded Electronic Packaging Association Symposium, Lockheed Missiles and Space Division's Palo Alto Research Facility, Calif., Aug. 21.

National Academy of Sciences 10th Pacific Science Congress, University of Hawaii, Honolulu, Aug. 21-Sept. 8.

Western Electronics Show and Convention (WESCON), Cow Palace, San Francisco, Aug. 22-25.

American Rocket Society Fourth Biennial Gas Dynamics Symposium, cosponsored with Northwestern University, Technological Institute, Evanston, Ill., Aug. 23-25.

American Institute of Electrical Engineers, Pacific General Meeting, Salt Lake City, Aug. 23-25.

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editorial . . .

Increasing Activity on Planet Earth

EXPANSION of the missile/space industry internationally is evident in the pages of this annual encyclopedia issue. More nations are building more missiles and space probes than ever before.

Limitations of national budgets will prevent most countries from ever undertaking individual space exploration on a scale comparable with that of the United States and the Soviet Union.

But two developments abroad are fostering a growth of missile/space interest. One is the pooling of national resources as in the European Space Club. The other, a realization that weather probes, small satellites and tactical missiles are not out of the financial reach of a number of countries.

West Germany's decision to participate in the European cooperative satellite launching program lifts a major obstacle from its path. There are others still to be met if the project is not to degenerate into a Tower of Babel due to language difficulties, differing engineering standards, varying national goals and the normal confusion generated when you put an Englishman, a Frenchman and a German in the same room.

A nation of West Germany's diverse industrial talents can be expected to move swiftly in the missile/space field now that a start has been made. As noted in our special report on the Paris Air Show, West Germany made its debut there in the postwar space field with a modest sounding rocket. Others are under development. Now comes the decision to join the European Space Club.

When the day comes, will Germany's wartime opponents express concern at some point over the size of German rockets built to lift peaceful satellites and space stations into orbit—but which are capable of lifting other things? Probably. And undoubtedly do nothing about it. So we anticipate in the years ahead a significant resurgence of German interest in the missile/space field.

Britain, in addition to the large role it is expected to play in the cooperative satellite launching program, has a number of other projects under way. A British payload for ionosphere measurements is to be placed in orbit by a NASA *Scout* next year. A second British satellite is to be launched in 1963 by a *Scout*. Considerable work is being carried out by British sounding rockets launched in Australia.

Canada is undertaking an extensive series of ionosphere probes and the launch of an earth satellite in 1962.

The Soviet Union has outlined a long-range space program which includes surveillance satellites in polar orbit, earth-orbiting space stations, two manned moon vehicles and reconnaissance rockets to each planet.

Whether all these efforts abroad can be greeted with equanimity, only the years ahead will tell. But there is one cloud on the international horizon which requires some immediate thought.

THAT IS THE THREAT of a "weather rocket" war between Israel and the United Arab Republic. Successful launch of the Israeli rocket coupled with official comments on "grave defense problems" which gave it priority brought immediate disclosure that Cairo is purchasing weather rockets in the U. S.

If it were not so serious, the prospect of the Israelis and the Arabs lofting weather rockets at each other might be sufficiently amusing to provide the plot for a comedy starring Alec Guinness and Peter Sellers. But anyone who watched the Israeli rout of the Egyptians in the Suez fighting is well aware of the deep feelings which still smoulder in that region. Hot tempers and launch pads are a poor combination. Some serious thinking should be done before approval is given to private firms to ship these rockets off to Cairo. It is not an easy problem for the State Department, which must decide whether to grant the export licenses.

But it certainly emphasizes our point that there is a growing interest abroad in missile/space activities.

William J. Coughlin

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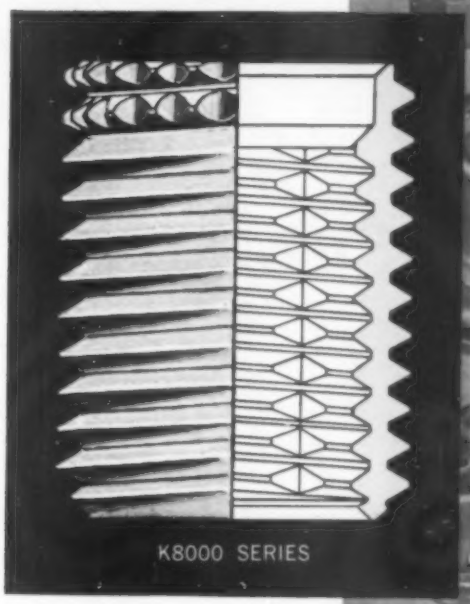

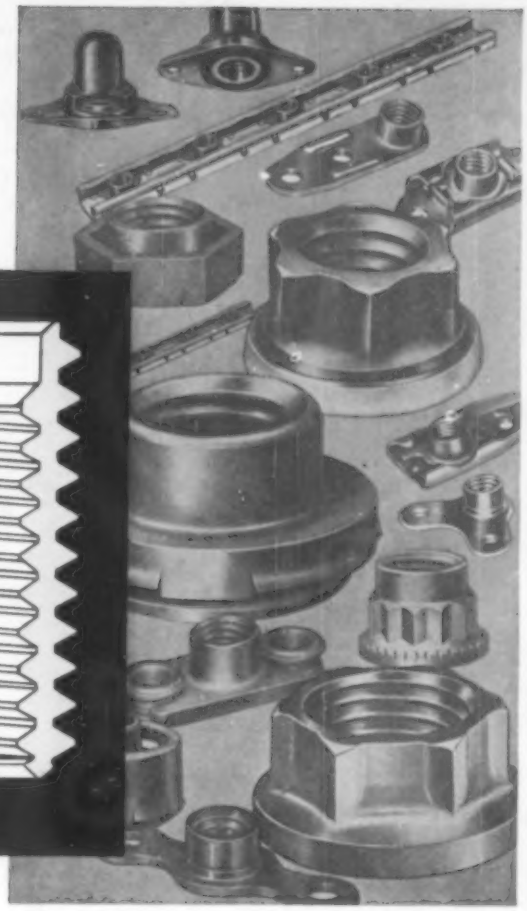

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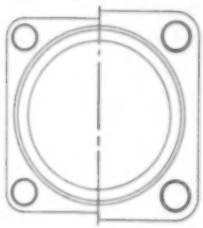

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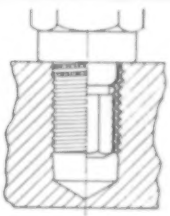

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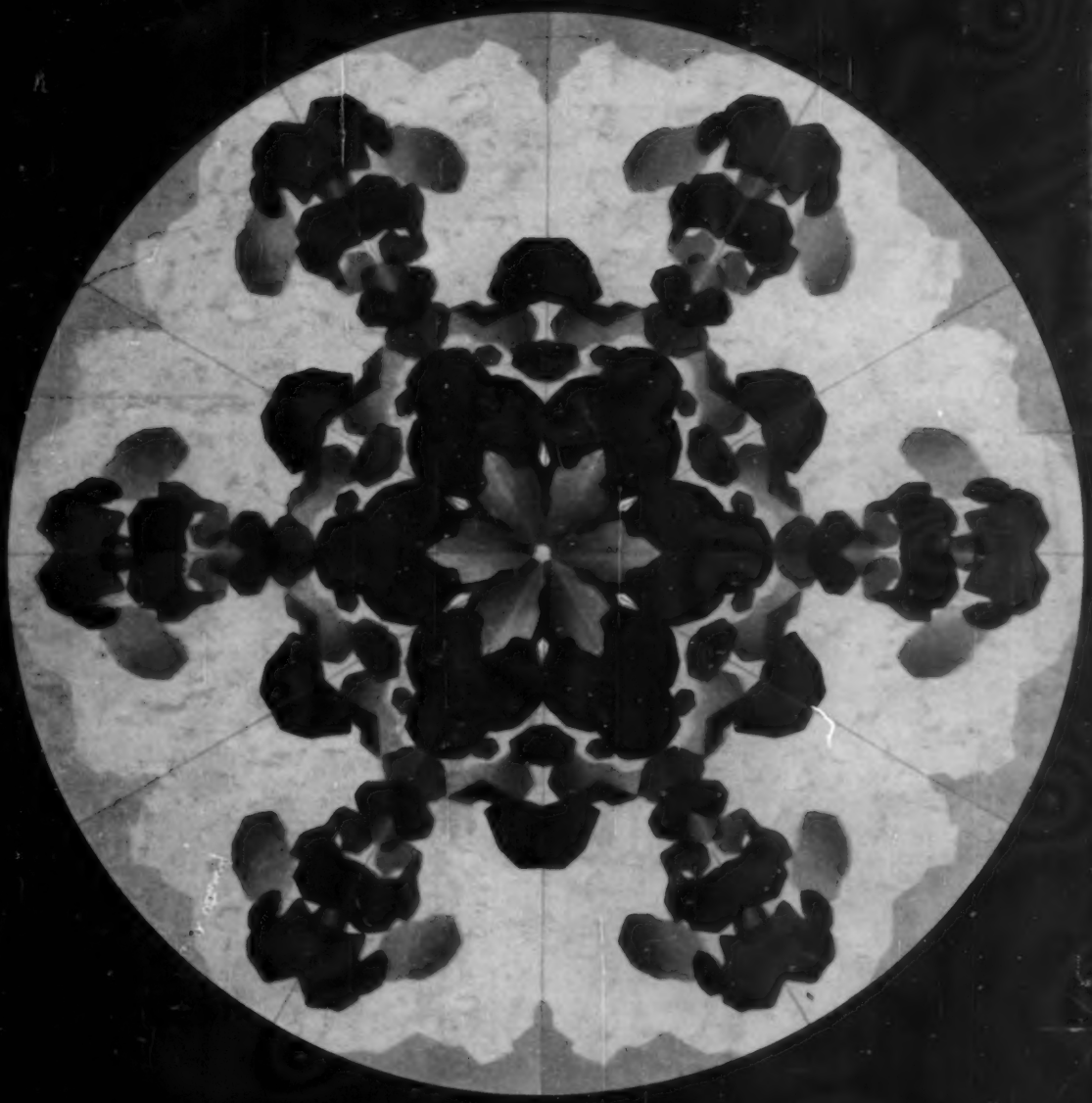

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